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DEPARTMENT OF COMMERCE AND LABOR

REPORT

OF THE

BUREAU OF FISHERIES

1904

GEORGE M. BOWERS
COMMISSIONER

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DEPARTMENT OF COMMERCE AND LABOR,
BUREAU OF FISHERIES,
Washington, September 15, 1904.

SIR: I have the honor to transmit herewith the report of the operations of the Bureau of Fisheries for the fiscal year 1904, consisting of a general review of the work by the Commissioner and detailed accounts by the chiefs of the respective divisions.

Respectfully submitted.

GEO. M. BOWERS,
Commissioner.

The SECRETARY OF COMMERCE AND LABOR.

REPORT OF THE COMMISSIONER OF FISHERIES

FOR THE

FISCAL YEAR ENDING JUNE 30, 1904.

GENERAL RESULTS.

During the first year's operations of the Bureau of Fisheries as a component of an executive department, after thirty-three years' existence as an independent commission, it is to be noted that the practical work has proceeded on the same general lines as heretofore, that the results attained in all branches have been satisfactory, and that the outlook for greatly augmented work is very favorable.

The efforts of the government on behalf of the fisheries are yearly becoming more generally appreciated, and a desire actively to cooperate with the Bureau has been manifested throughout the country by all persons directly or indirectly interested in the promotion of fishing as a business or as a pastime. The sums voted annually for expenditure through this channel represent only about one per cent of the value of our fisheries; the preservation of some of the most important of these is now largely dependent on the Bureau's operations; and it is easily demonstrable that in pursuing a liberal policy for the promotion of the fishing industry Congress is simply making an investment that yields returns far greater than those which attend private business enterprises.

The succeeding references to the character and scope of the Bureau's operations and the more extended accounts of the work in the various branches of the service will be supplemented by special articles in the annual report and bulletin.

PROPAGATION AND DISTRIBUTION OF FOOD-FISHES.

LEADING FEATURES OF THE WORK.

The year 1904 was one of the most successful in the history of the Bureau, considered with reference to the operations of the hatcheries. The total distributions, which have been equaled by those of only a single previous season (1902), exceeded 1,250,000,000. The conditions attending the hatching of such a large number of fishes necessitate the planting of most of them in the form of fry; but increased attention

has been given to the rearing of important species wherever practicable, and the output of adult, yearling, and fingerling fish was nearly 50 per cent larger than in any previous year.

The importance of the Bureau's fish-cultural operations, however, must not be gauged by the results during any one year, but by the average for a series of years. Peculiar seasonal conditions often materially modify the work of particular stations, sometimes favorably, more often unfavorably, and give an erroneous impression as to its extent. It usually transpires that a year which is characterized by a greatly diminished yield of certain fishes is noteworthy for an augmented output of others, so that the aggregate distributions remain normal. This point, which has frequently been emphasized and illustrated in previous reports, was exemplified anew in 1904, when an exceedingly poor season for shad and white-fish was offset by the largest collections of eggs of Pacific salmons and flat-fish ever known.

An important feature of the work of artificial propagation, which has often been referred to but can not be too strongly emphasized, is that an exceedingly large percentage of the young fish hatched annually are from eggs taken from fish that have been caught for market, and hence would be totally lost were it not for the efforts of the Bureau. To the many hundred millions of young food and game fishes thus produced must be added many more millions resulting from the superiority of artificial propagation over natural propagation in the matters of fertilizing and incubating eggs and of safety of the young.

STATIONS OPERATED.

The fish-cultural work of the Bureau in 1904 was conducted in 26 states, at 49 stations and substations. In respect to their output, the substations are in most cases of equal, in some cases of greater, importance than the stations, but their equipment is less complete and for administrative purposes they are subordinated, and their personnel supplied from the stations to which they are attached.

The demand and the local facilities determine the proportion of effort directed toward the cultivation of the important commercial species. During the past year the salmons were propagated at 11 stations; white-fish at 7; lake trout at 5; shad at 4; pike perch at 3; cod at 2; flat-fish at 2; striped bass, white perch, and yellow perch at 1 each; and the lobster at 2.

THE SPECIES CULTIVATED AND DISTRIBUTED.

The number of species now regularly cultivated and distributed by the Bureau is upward of 50, and the artificial propagation of new fishes is being taken up as the work increases and the demand arises. A full list of the species handled in 1904 follows, from which it will be seen that in every section, so far as the existence of hatcheries permits, the supply of the important food and game fishes is being increased by the Bureau's

efforts. Thus, in the rivers of the Atlantic seaboard shad, salmon, striped bass, white perch, and yellow perch have been planted; in the streams of the Pacific coast, quinnat salmon, blueback salmon, silver salmon, humpback salmon, and steelheads; the Great Lakes have been stocked with white-fish, lake herring, lake trout, and pike perch; the numerous interior lakes, ponds, and streams have been enriched by plants of landlocked salmon, rainbow trout, black-spotted trout, brook trout, grayling, black bass, calico bass, crappie, rock bass, sun-fish, etc.; and in the waters of the northeast coast the supply of cod, pollock, flat-fish, and lobster has been increased.[a]

The Cat-fishes (SILURIDÆ).
* § Spotted Cat, Blue Cat, Channel Cat (*Ictalurus punctatus*).
* § Horned Pout, Bullhead, Yellow Cat (*Ameiurus nebulosus*).
* Marbled Cat (*Ameiurus nebulosus marmoratus*).
§ Black Cat (*Ameiurus melas*).

The Suckers and Buffalo-fishes (CATOSTOMIDÆ).
§ Small-mouth Buffalo-fish (*Ictiobus bubalus*).

The Minnows and Carps (CYPRINIDÆ).
† ‡ Carp (*Cyprinus carpio*). Cultivated varieties, German Carp, Leather Carp, Mirror Carp, etc.
‖ ‡ Gold-fish (*Carassius auratus*).
‖ ‡ Tench (*Tinca tinca*). Cultivated variety, Golden Tench.
‖ ‡ Ide (*Leuciscus idus*). Cultivated variety, Golden Ide.

The Shads and Herrings (CLUPEIDÆ).
* Shad (*Alosa sapidissima*).

The Salmons, Trouts, White-fishes, etc. (SALMONIDÆ).
* White-fish (*Coregonus clupeiformis*).
* Lake Herring, Cisco (*Argyrosomus artedi*).
* Quinnat Salmon, Chinook Salmon, Tyee Salmon, King Salmon (*Oncorhynchus tschawytscha*).
* Silver Salmon, Coho (*Oncorhynchus kisutch*).
* Blueback Salmon, Red-fish, Sockeye (*Oncorhynchus nerka*).
* Humpback Salmon (*Oncorhynchus gorbuscha*).
* Steelhead, Hardhead, Salmon Trout (*Salmo gairdneri*).
* Rainbow Trout (*Salmo irideus*).
* Atlantic Salmon (*Salmo salar*).
* Landlocked Salmon (*Salmo sebago*).
* Yellowstone Lake Trout, Cut-throat Trout, Black-spotted Trout (*Salmo lewisi*).
* Colorado River Trout, Black-spotted Trout (*Salmo pleuriticus*).
* Arkansas River Trout, Green-backed Trout (*Salmo stomias*).
* Yellow-finned Trout (*Salmo macdonaldi*).
‡ * Sea Trout, Salmon Trout (*Salmo trutta*).
‡ * Loch Leven Trout (*Salmo trutta levenensis*).
* Lake Trout, Mackinaw Trout, Longe, Togue (*Cristivomer namaycush*).
* Brook Trout, Speckled Trout (*Salvelinus fontinalis*).
* Golden Trout, Sunapee Lake Trout (*Salvelinus aureolus*).
* Canadian Red Trout (*Salvelinus marstoni*).
* Hybrid Trout (*Salvelinus fontinalis+aureolus*).

[a] The fishes artificially propagated are designated thus, *; those simply collected and distributed thus, §; those propagated as food for other fishes thus, †; those propagated for ornamental purposes thus, ‖; and introduced species thus, ‡.

The Graylings (THYMALLIDÆ).
* Montana Grayling (*Thymallus montanus*).
The Mackerels (SCOMBRIDÆ).
* Common Mackerel (*Scomber scombrus*).
The Basses, Sun-fishes, and Crappies (CENTRARCHIDÆ).
* § Crappie (*Pomoxis annularis*).
* § Strawberry Bass, Calico Bass (*Pomoxis sparoides*).
* § Rock Bass, Red-eye, Goggle-eye (*Ambloplites rupestris*).
* § Warmouth, Goggle-eye (*Chaenobryttus gulosus*).
* § Small-mouth Black Bass (*Micropterus dolomieu*).
* § Large-mouth Black Bass (*Micropterus salmoides*).
* § Blue-gill Sun-fish (*Lepomis pallidus*).
The Perches (PERCIDÆ).
* § Pike Perch, Wall-eyed Pike, Yellow Pike, Blue Pike (*Stizostedion vitreum*).
* § Yellow Perch (*Perca flavescens*).
The Sea Basses (SERRANIDÆ).
* Striped Bass, Rock-fish (*Roccus lineatus*).
* White Perch (*Morone americana*).
The Cods (GADIDÆ).
* Cod (*Gadus callarias*).
* Pollock (*Pollachius virens*).
The Flounders (PLEURONECTIDÆ).
* Winter Flounder (*Pseudopleuronectes americanus*).
Crustaceans.
* American Lobster (*Homarus americanus*).

The Bureau long since discontinued the cultivation of carp, and does not favor the further indiscriminate planting of this species; that the demand for the fish is not satisfied, however, notwithstanding its wide dispersal, is shown by the numerous applications received from all parts of the country for supplies of carp for private and public waters. It is the practice to satisfy these requests by the substitution of better native species, among which the cat-fishes may be mentioned. The fishes of this family are adapted to such different conditions, are so hardy and prolific, and are so wholesome, that they are among the best fishes available for the stocking of certain waters. The demand is increasing, and the Bureau is endeavoring to meet it by taking up cat-fish culture incidentally and on a necessarily small scale at several hatcheries; but the time seems to have arrived when a special station for the cultivation of the cat-fishes is required.

Various water animals are now under investigation that may eventually lead to their wholesale propagation by the Bureau, among such being the sea mullet, the most valuable fish of the South Atlantic and Gulf States; the common blue crab; the diamond-back terrapin, and the green sea turtle.

THE OUTPUT SUMMARIZED.

The number of fish and fertilized eggs distributed by the Bureau in 1904 is given by species in the appended summary. The aggregate output of 1,267,343,025 was divided as follows: Fertilized eggs,

263,123,354; fry, 994,503,040; fingerlings, yearlings, and adults, 9,716,631. The eggs shown were for the most part donated to various states to be incubated in their own hatcheries, the resulting fry being planted under the direction of the state fishery authorities. The number of fish and eggs of each of three species distributed exceeded 200,000,000; the output of each of two others was over 100,000,000, and of six others upward of 20,000,000.

It is worthy of remark that while the Bureau makes ample provision for maintaining the supply of fishes caught chiefly by anglers, nearly 99 per cent of the fish handled are those which are the objects of commercial fisheries.

Summary of distribution of fish and eggs during the fiscal year 1904.

Species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.	Total.
Shad	13,169,000	65,493,000		78,662,000
Quinnat salmon	75,217,354	35,006,988	4,125	110,228,467
Silver salmon		3,984,645		3,984,645
Blueback salmon		3,855,000		3,855,000
Humpback salmon		176,597		176,597
Atlantic salmon	25,500	2,566,716	369,000	2,961,216
Landlocked salmon	122,500	27,200	411,428	561,128
Steelhead trout	161,000	102,705	230,435	494,140
Loch Leven trout		182,300	2,291	184,591
Rainbow trout	214,000	471,378	523,103	1,208,481
Blackspotted trout	469,000	19,315	6,646,139	7,134,454
Lake trout	3,060,000	18,486,460	43,831	21,590,291
Brook trout	541,000	7,221,536	842,452	8,604,988
Golden trout		36,000	30	36,030
Canadian Red trout			13	13
Grayling	334,000	2,692,200	255	3,026,455
White-fish	60,315,000	176,485,000		236,800,000
Lake herring		23,300,000		23,300,000
Pike perch	109,495,000	181,706,000		291,201,000
Yellow perch		23,263,000		23,263,000
Striped bass		3,898,000		3,898,000
White perch		29,350,000		29,350,000
Large-mouth black bass			488,490	488,490
Small-mouth black bass			16,392	16,392
Crappie			22,172	22,172
Strawberry bass			2,654	2,654
Rock bass			49,774	49,774
Warmouth bass			6,270	6,270
Bream or sun-fish			39,920	39,920
Cat-fish			17,857	17,857
Cod		79,455,000		79,455,000
Pollock		1,246,000		1,246,000
Mackerel		324,000		324,000
Flat-fish		228,272,000		228,272,000
Lobster		106,882,000		106,882,000
Total	263,123,354	994,503,040	9,716,631	1,267,343,025

DISTRIBUTIONS IN THE DIFFERENT STATES.

The fish-cultural operations of the Bureau affect every state and territory, as the following condensed table shows. Of the 1,264,408,025 fish and eggs distributed in the United States, Massachusetts received the largest assignment, 363,854,407, owing to the concentration of marine fishery work in that state; 202,166,318 were distributed in Ohio and 169,544,407 in Michigan waters; Pennsylvania received 81,687,230, Maine, 67,232,963, California, 66,807,484, and other states and territories according to their needs and the capacity of the hatcheries.

Distributions and assignments of fish and eggs in the states and territories during the fiscal year 1904.

State or territory.	Fish and eggs distributed.	State or territory.	Fish and eggs distributed.
Alabama	48,250	Nebraska	98,800
Arizona	10,030	New Hampshire	2,985,740
Arkansas	34,005	New Jersey	6,859,950
California	66,807,484	New Mexico	215,075
Colorado	5,144,060	New York	26,248,275
Connecticut	6,833,425	North Carolina	12,275,025
Delaware	6,001,400	North Dakota	312,850
District of Columbia	995,200	Ohio	202,166,318
Florida	3,950	Oklahoma	9,458
Georgia	2,563,790	Oregon	27,157,687
Idaho	251,200	Pennsylvania	81,687,230
Illinois	15,998	Rhode Island	2,951,800
Indiana	11,533,860	South Carolina	1,184,600
Indian Territory	3,220	South Dakota	2,786,638
Iowa	1,944,800	Tennessee	48,025
Kansas	16,470	Texas	139,216
Kentucky	1,891,689	Utah	202,000
Louisiana	4,356	Vermont	31,514,721
Maine	67,232,963	Virginia	29,148,858
Maryland	59,121,458	Washington	24,768,160
Massachusetts	363,854,148	West Virginia	1,728,011
Michigan	169,544,407	Wisconsin	12,147,050
Minnesota	5,881,200	Wyoming	824,300
Mississippi	51,882		
Missouri	24,642,513	Total	1,264,408,025
Montana	3,016,450		

CAR AND MESSENGER SERVICE.

The distribution of the output of the various hatcheries is accomplished by means of the Bureau's five railway cars especially designed for the purpose, and a corps of detached messengers who accompany consignments of fish in baggage cars to the less accessible places. The cars traveled 70,221 miles in the past year, the messengers 103,177 miles. Free transportation was furnished by a number of railroad companies, as shown in the following table, and acknowledgment is hereby made of this courtesy and liberality.

Statement of miles of free transportation furnished by various railroads during the year 1904.

Name of railroad.	Cars.	Messengers.	Name of railroad.	Cars.	Messengers.
Atchison, Topeka and Santa Fe		525	Grand Rapids and Indiana		316
Baltimore and Ohio	640		Grand Trunk		47
Bangor and Aroostook	1,848	969	Gulf, Colorado and Santa Fe		11,248
Boston and Maine		12,393	Houston, East and West Texas		296
Burlington and Missouri River		5,043	Houston and Texas Central		2,488
Central Vermont		28	Illinois Central		493
Chesapeake and Ohio		380	International and Great Northern		14,632
Chicago, Burlington and Quincy		385	Iron Mountain and Greenbrier		32
Chicago and Northwestern		1,698	Kansas City Southern		1,006
Chicago, Rock Island and Pacific		426	Lexington and Eastern		74
Colorado Midland		967	Maine Central	5,543	558
Colorado and Southern		3,354	Missouri Pacific	980	1,846
Colorado Springs and Cripple Creek District		174	Mobile and Ohio	878	
Corvallis and Eastern		56	Montana	628	
Crystal River		34	Montpelier and Wells River		478
Delaware, Lackawanna and Western	290		New York Central and Hudson River		172
Denver and Rio Grande		12,401	Norfolk and Western		2,701
Detroit and Mackinac		504	Northern Pacific		54
Fort Worth and Denver City		2,004	Oregon Short Line	724	
Franklin and Megantic		90	Pennsylvania	456	
Galveston, Harrisburg and San Antonio		209	Pere Marquette		3,169
			Phillips and Rangeley		58

Statement of miles of free transportation furnished by various railroads during the year 1904—Continued.

Name of railroad.	Cars.	Messengers.	Name of railroad.	Cars.	Messengers.
Portland and Rumford Falls	376		Sandy River		82
Rio Grande Southern		142	Somerset		164
Rio Grande Western		708	Southern Kansas		260
Rumford Falls and Rangeley Lake		184	Southern Pacific		1,840
Rutland		743	Texas and New Orleans		267
St. Johnsbury and Lake Champlain		864	Texas and Pacific	1,063	5,452
St. Louis and San Francisco	1,309	3,884	Vandalia	254	
St. Louis Southwestern		709	Wabash		1,592
San Antonio and Aransas Pass		758	Washington County	204	
			Total	15,193	98,957

RELATIONS WITH THE STATES.

The Bureau maintains close relations with the fishery authorities of the states, and cooperates with them to the fullest extent in the promotion of local fishery interests. This cooperation is of mutual benefit, and the results are often much greater than would be possible were the government and the states to pursue independent courses. The Bureau is pleased to defer to the state officers in all matters affecting local conditions, and does not take any part in state fishery legislation.

Donations of eggs and fish have been made to the fish commissions of 18 states, under whose direction the eggs were hatched and the fry distributed. The allotments to the states, as shown in detail in the table, aggregated more than 244,000,000, representing 13 species of food fishes.

Allotments of eggs and fish to the state fish commissions in 1904.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
California:			
Brook trout	200,000		
Grayling	100,000		
Landlocked salmon	10,000		
Quinnat salmon	64,147,354		
Colorado:			
Steelhead trout	40,000		
Connecticut:			
Lake trout	200,000		
Landlocked salmon	10,000		
Rainbow trout	22,000		
Shad		3,000,000	
Maine:			
Landlocked salmon	25,000		
Quinnat salmon	100,000		
Steelhead trout	20,000		
Maryland:			
Shad	5,989,000		
Massachusetts:			
Pike perch	5,000,000		
Rainbow trout	30,000		
Michigan:			
Grayling	100,000		
Lake trout	2,300,000		
Loch Leven trout			30
Pike perch	47,495,000		
Steelhead trout			15
Minnesota:			
Rainbow trout			34,800

Allotments of eggs and fish to the state fish commissions in 1904—Continued.

State and species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Missouri:			
Grayling	46,000		
Pike perch	10,000,000		
Nebraska:			
Brook trout	50,000		
Rainbow trout	33,000		10,000
New Hampshire:			
Atlantic salmon	20,000		
Lake trout	100,000		
Landlocked salmon	10,000		
Quinnat salmon	100,000		
Steelhead trout	20,000		
New York:			
Brook trout		200,600	
Lake trout	200,000		
White-fish	2,000,000		
Oregon:			
Brook trout		1,000	
Quinnat salmon	10,569,000		
Pennsylvania:			
Atlantic salmon	3,000		
Lake trout	200,000		
Pike perch	35,000,000		
Rainbow trout			1,000
White-fish	46,280,000		
Utah:			
Brook trout	50,000		
Vermont:			
Brook trout		5,000	
Wisconsin:			
White-fish	10,000,000		
Wyoming:			
Black spotted trout	400,000		
Grayling	50,000		
Rainbow trout	25,000		
Total	240,944,354	3,206,600	45,845

At the request of the Michigan fish commissioners, the Bureau has continued to operate the state hatcheries at Detroit and Sault Ste. Marie, directing its efforts there to the propagation of white-fish, lake trout, and pike perch. Negotiations are in progress with a view to the taking over by the Government of other state hatcheries which for various reasons the local authorities do not care to operate.

In its efforts to maintain the supply of commercial fishes, the Bureau has nowhere labored more assiduously and expended more money than in Michigan, which state has most valuable fishery interests at stake in all of the Great Lakes except one. For many years the fish-cultural work of the government on the Great Lakes has been on an immense scale, far exceeding that in any other section of the country, and of the unmistakable benefits resulting therefrom the Michigan fishermen have reaped the largest share. Notwithstanding these facts, however, the fish wardens of Michigan have for a number of years made determined efforts to interfere with and curtail the work of the Bureau's representatives, raising petty objections to the methods pursued in the collection of spawn. Their shortsighted and unwarranted actions have caused great annoyance and at times have threatened completely to stop fish-cultural work in the Michigan waters of the Great Lakes. During several years matters were at an acute stage, but it was not

until the fall of 1903 that a crisis came, resulting in the arrest of employes of the Bureau by State officers. In view of the important bearing of this case on the work of the Bureau in the Great Lakes region, it is considered advisable to refer to it in some detail by citing laws, correspondence, and judicial proceedings, as follows:

Section 4398, Revised Statutes of the United States, regarding powers of the United States Fish Commission.

The Commissioner may take or cause to be taken at all times, in the waters of the sea coast of the United States, where the tide ebbs and flows, and also in the waters of the lakes, such fish or specimens thereof as may, in his judgment, from time to time be needful or proper for the conduct of his duties, any law, custom, or usage of any state to the contrary notwithstanding.

Section 6, Act 88, Public Acts of Michigan, 1899.

It shall be lawful for the United States Fish Commission, through its representatives or employees, to fish with nets in any of the waters of this State during any season of the year, for the purpose of gathering spawn from such fish caught, to have and to hold both ripe and unripe fish, *and to have the privilege of selling such fish after stripping*, to help defray the expenses incurred in the work of propagation: *Provided*, That such fishing by said fish commission shall be under the supervision and control of the state game and fish warden, *and, provided further*, That at least 75 per cent of the fry resulting from the spawn so taken shall be planted in the waters of this State, the same to be determined by reports to the state game and fish warden.

Letter of S. P. Wires, superintendent United States hatchery, Duluth, Minn., October 23, 1903, to C. H. Chapman, state fish warden, Sault Ste. Marie, Mich.

On behalf of the United State Fish Commission, I respectfully request your permission to continue fishing with tugs at Marquette and Ontonagon a few days, if practicable, after the beginning of the close season. We desire to comply fully with your wishes and the law of your state in the conduct of this work, and any instructions you may give us in relation thereto will be carefully carried out.

On the first day of the close season last year we wired your predecessor, Mr. Morse, the names of the tugs we were operating, also the names of the masters of the tugs, and each day thereafter we reported direct to him the number of pounds of fish taken by each tug, and last June we mailed your office a statement showing the number of eggs collected in Michigan during the close season and the number of fry planted in Michigan waters from the Duluth station, and so far as I know everything was entirely satisfactory.

I am under the impression that we discontinued fishing last season at Ontonagon on the 4th and at Marquette on the 7th of November.

An early reply will greatly oblige.

Telegram of S. P. Wires, Duluth, October 27, to state fish warden, Sault Ste. Marie.

In order to fully stock the United States Fish Commission station, Duluth, with lake trout eggs, it will be necessary to continue fishing with two or three tugs at Marquette and probably two at Ontonagon, Mich., a few days after the beginning of the close season, but it will be impossible to give any portion of the fish caught while engaged in this work to the state, as the total catch of fish will fall considerably short of paying the expenses of collecting the eggs. Will you insist upon taking the unstripped fish? Please wire reply.

Telegram of state fish warden, Sault Ste. Marie, October 28, to S. P. Wires, Duluth.

I have no power to change the law; fish not spawners belong to the state of Michigan.

Telegram of S. P. Wires, Duluth, October 28, to United States Commissioner of Fisheries, Washington, D. C.

To procure a full stock of eggs for the Duluth station it will be necessary to continue fishing at Marquette and Ontonagon a few days after October 30, as we did last year; but if compelled to turn over to the state all unstripped fish it will in my judgment be impracticable to do so. The game and fish warden of Michigan claims that all unripe fish caught by the United States Fish Commission during the close season are state property. Please advise.

Telegram of United States Commissioner of Fisheries, October 29, to S. P. Wires, Duluth.

Make collection of lake-trout eggs same as last season.

Telegram of S. P. Wires, Marquette, Mich., November 4, to United States Commissioner of Fisheries

State game and fish warden has arrested captains of tugs fishing for us at Marquette. Have four gang nets in lake at this point. Should have competent attorney to look after the interests of the Commission at once. Please advise.

Telegram of United States Commissioner of Fisheries to S. P. Wires, Marquette, November 4.

Matter will be referred to Department of Justice and Attorney-General will probably instruct district attorney to look after interests of this Bureau.

Telegram of S. P. Wires, Marquette, Mich., November 4, to United States Commissioner of Fisheries.

Have had trial against masters and owners adjourned until the 11th instant. Tugs will lift to-morrow. Game warden threatens to seize all fish caught from now on. Wire instructions.

Letter of Frank N. Clark, superintendent United States hatchery, Northville, Mich., October 31, to United States Commissioner of Fisheries.

On my arrival at the Soo Tuesday morning, October 27, I found your telegram ordering me to "proceed with lake-trout collection and dispose of fish same as last season." Soon after receiving your telegram I had a conference with Mr. Chapman, state game and fish warden, and told him I should proceed to make the lake-trout collection on the same lines as last season, in accordance with your orders. He stated that the attorney-general of the state informed him we had no right to sell unripe fish, but he would confer with him again and obtain a written opinion, and if he still held to his former opinion, the warden thought it best to start a friendly suit in order to test the law, and asked me to write the Bureau and see if you would agree to it. I think it best to have the matter tested in the courts, if we are to be bothered by the warden in this manner every year.

From the Soo I went to Manistique to confer with Mr. Platts, the field foreman at that point, and Capt. John Coffy, who is fishing three tugs for us. Coffy informed me it would be impossible for him to fish for us under the requirements of the warden. I then informed him that we would fish the same as last year.

On my return to Northville I found a telegram from Mr. Stewart, field foreman at Beaver Island, stating the tug fishermen at Beaver Island refused to fish on the basis required by the warden, and he has also been instructed to fish on the old system.

As yet very few eggs have been received from Manistique; information from Platts

yesterday says 20 per cent of the females are spawning. As that was the last day of the open season, nets will be set, and if 50 per cent of the spawners are ripe, the work will be pushed vigorously.

Telegram of F. N. Clark, Mackinaw City, November 10, to United States Commissioner of Fisheries.

Court temporarily enjoined warden not to interfere. Hearing 24th instant Grand Rapids. Warden assures superintendent no interference, Detroit River, even if injunction dissolved.

Letter of S. P. Wires, Duluth, November 13, to United States Commissioner of Fisheries.

In regard to our trouble with Mr. Chapman, game and fish warden of Michigan, permit me to state that I tried to arrange matters with him so as to continue fishing for a few days after the beginning of the close season under the Michigan laws, but was unable to come to a satisfactory understanding, so I wired him after receiving instructions from you that we would continue fishing with the tugs *Columbia* and *Theora* at Marquette, Mich., under the same regulations as we did a year ago, and everything went along smoothly until the morning of the 3d instant, when Mr. Brewster, chief deputy warden, and two assistants, undertook to go aboard the tugs for the purpose of supervising our work and to seize all unstripped fish for the state. We could not allow this, as it would lay each tug captain liable to a fine of $500, also to have his license for sailing a steamboat canceled; consequently Mr. Brewster was very much provoked and arrested the captains and owners for illegal fishing shortly after the tugs returned from lifting, but did not seize fish or nets. However, the arrest of the captains caused us to lose from 500,000 to 600,000 eggs, as no lift could be made on the 4th.

In order that we might continue fishing until the close of the spawning season, or until we could get definite orders from you, I employed a competent attorney and had the hearing of the captains and owners adjourned for one week, but owing to unfavorable weather was unable to lift on the 5th, and after lifting two gangs of nets on the 6th, we concluded that it was time to discontinue work, as many of the fish taken on that date were through spawning and there were very few unripe fish.

When the tugs returned from lifting on the 6th, all nets and fish were seized and turned over to the captains of the tugs to be cared for, and the same was done on the 7th, when the last nets were brought ashore, and all spawn takers, including Frank Thomas and myself, were arrested on the evening of the 6th for fishing in violation of the state game and fish laws, and in order to save time and expense, my attorney advised me to admit certain facts in connection with the case, and if found guilty, to take an appeal, which I did.

Decision of United States Judge Wanty.

In the circuit court of the United States for the western district of Michigan, United States of America, complainant, *v.* Charles Chapman and Charles E. Brewster, defendants, memorandum for judgment on order to show cause:

Under the acts of Congress providing therefor, the President of the United States appoints a Commissioner of Fish and Fisheries, whose duty it is to investigate the subject with a view to ascertaining what diminution, if any, in the number of food fishes of the coast and the lakes of the United States has taken place, and from what cause the same is due, and whether any protective, prohibitory, or precautionary measures should be adopted in the premises, and report upon the same to Congress. It is also provided that the heads of the several Executive Departments shall cause to be rendered all necessary and practical aid to the Commissioner in the prosecution of his investigations and inquiries, and section 4398 of the Revised Statutes provides

that "the Commissioner may take or cause to be taken at all times in the waters of the seacoast of the United States, where the tide ebbs and flows, and also in the waters of the lakes, such fish or specimens thereof as may in his judgment from time to time be needful or proper for the conduct of his duties, any law, custom or usage of any State to the contrary notwithstanding."

On November 6, 1903, which was during the closed season under the Michigan statute, while the eggs of white-fish and trout for the purpose of propagation in Michigan were being gathered near Marquette, in Lake Superior, under the direction of S. P. Wires, superintendent of the United States fish hatchery at Duluth, he was arrested by the defendants in this case, and the fish in his possession were confiscated. The action of Superintendent Wires and his men in submitting to the humiliation of the forcible boarding of their boat and the seizure and confiscation of the fish, without forcible resistance, and appealing to the courts where controversies of this nature between the two sovereign governments should be settled without friction, can not be too highly commended.

The defendants are the Michigan state game and fish warden and his deputy, who claim that all fishing by the United States Commissioner of Fish and Fisheries in the Great Lakes bordering on the state of Michigan must be done under their supervision, and that the only right the United States Fish Commission has to fish, for the purpose for which Congress created it, in Michigan waters during the closed season, is considered by act No. 88 of the Public Acts of 1899, which reads: "It shall be lawful for the United States Fish Commission, through its representatives or employees, to fish with nets in any of the waters of this state, during any season of the year, for the purpose of gathering spawn from such fish caught, to have and to hold both ripe and unripe fish, and to have the privilege of selling such fish after stripping to help defray the expense incurred in the work of propogation; that such fishing by said Fish Commission shall be under the supervision and control of the state game and fish warden: *And provided further*, That at least seventy-five per cent of the fry resulting from the spawn so taken shall be planted in the waters of this state, the same to be determined by reports to the state game and fish warden."

A deputy of the state game and fish warden demanded the right to superintend the fishing operations of the United States Commissioner of Fish and Fisheries, which demand was refused, and he then seized and confiscated the fish in the possession of the Commissioner's agents, and caused the arrest of Wires and the persons found assisting him.

If the United States has the right which Congress evidently intended to confer by the legislation above quoted, and a deputy game warden can legally interfere with the exercise of that right, in the manner admitted in the answer filed in this case, then the Government is entitled to the contempt which the deputy game warden exhibited toward it. The United States can not undertake any work where it is not supreme, and a Government officer could not, in any legitimate function of the Government, be under the direction and control of a state officer. If the Federal statute, by which it was intended to confer on the Commissioner the right to take or cause to be taken in the waters of the lakes such fish as in his judgment is needful for the proper conduct of his duties, is constitutional, the legislation is exclusive, and any act of any state, so far as it conflicts with that legislation, is void. The Attorney-General in his brief says: "The defendants contend that the right of complainant to so take fish can be exercised only pursuant to the authority granted to the United States Fish Commission by the laws of the state of Michigan; that the power of complainant is limited and defined by those laws, and that any enactment of Congress contravening the statutes of this state in relation to such fishing is unconstitutional and void." The act of Congress, if invalid, is so because it conflicts with the Federal Constitution, and not because it contravenes the statutes of the state of Michigan. If it is decided that the United States has no right to take fish, under

the act of Congress, its propagation of food fishes must cease, because it would be intolerable for it to exercise any of its functions under the direction and control of persons over whom it has no authority.

If the acts of Congress creating this department are void, the Government must of necessity suspend it, and such suspension would mean an immense loss to the state of Michigan, and probably a much greater loss to the states bordering on tide water, where shellfish are propagated. The constitutionality of this legislation has not before been questioned in the courts, and if the laws of the United States seeking to confer upon the Commissioner of Fish and Fisheries the right at all times to take fish needful for the conduct of his duty, notwithstanding contrary legislation by the state, is unconstitutional, such grave consequences must flow from a judgment announcing it that it seems to me not proper to pass upon that question on a preliminary hearing where the preparation must of necessity be inadequate. The precipitate action of the defendants in this case indicates that a dissolution of the injunction would lead to an unseemly conflict which should be avoided, and therefore the injunction will remain in force until the final hearing of the cause.

RELATIONS WITH FOREIGN COUNTRIES.

Requests for the eggs of American fish for foreign countries have been received through diplomatic and other channels, and, as in previous years, have been complied with as far as practicable. For long-distance shipments only eggs with a protracted hatching period are available, and of these the salmonoid eggs are the most important. Upward of 2,500,000 of such eggs have been presented to Canada, Argentina, England, Wales, France, Japan, and New Zealand, as follows:

Countries.	Species.	Number of eggs.
Canada	Rainbow trout	20,000
Argentina	Steelhead trout	20,000
	Brook trout	100,000
	Lake trout	50,000
	White-fish	1,000,000
	Landlocked salmon	50,000
England	Rainbow trout	10,000
	White-fish	25,000
Wales	Black-spotted trout	25,000
France	Rainbow trout	10,000
Japan	Brook trout	25,000
New Zealand	White-fish	1,000,000
	Quinnat salmon	300,000
Total		2,635,000

Cordial relations exist between this Bureau and the department of marine and fisheries of the Province of Ontario. The minister permits the Bureau to collect white-fish and lake trout spawn in the Canadian waters of Lakes Superior and Erie, and in return for this privilege the Bureau makes plants of fry near the international boundary or in the Canadian waters adjacent thereto.

The eggs presented to the Argentine Republic marked the beginning of fish culture in that enterprising country. They were sent in care of a representative of the Bureau, were en route from forty-six to fifty days, and arrived at their destination and were hatched with an

average loss of less than 10 per cent. This is worthy of note, not only because it is probable that these eggs were transported a greater distance than has heretofore been recorded in the history of fish culture, but also from the fact that they were taken across the equator, and then carried by team 300 miles over the hot sands of the territory of Neuquen, to be hatched at just the opposite season of the year to that in which they would naturally have hatched in their home waters.

The eggs sent to the New Zealand government were also in charge of a Bureau agent. The white-fish eggs were in course of transportation thirty-four days and the salmon eggs twenty-seven days, a journey of 2,600 and 250 miles, respectively, by rail, and 6,600 miles by steamer, during which they were transhipped eighteen times in wagons, railway cars, and vessels before reaching their destination. The salmon eggs were delivered to the New Zealand inspector of fisheries at Auckland with an actual loss of less than one-half of 1 per cent, while the white-fish eggs were delivered at the same point with a loss of 10 per cent; in the reshipment from Auckland to Wellington by steamer there was a further loss of 10 per cent in the white-fish and a fraction of 1 per cent in the salmon eggs, probably due to the fact that they had to be transported during the final journey at a rather high temperature, there being no cold-storage facilities on board the steamer.

NEW STATIONS AND IMPROVEMENTS.

The purchase of the land selected for the new station at Mammoth Spring, Ark., was consummated June 24, 1904, and the preliminary topographical survey was at once begun. The site contains 15.52 acres, is in the town a short distance from the railroad station, and is thus conveniently located for shipping fish and handling supplies. The water is obtained from a large lake or reservoir formed by damming Mammoth Spring, which is a remarkable outflow of cold, pure water admirably suited to the propagation of fish. The deed of sale carries the right of drawing a maximum quantity of 1,200 gallons a minute from this reservoir.

At Tupelo, Miss., two stock ponds, each 3½ to 4½ feet in depth and about 1½ acres in area, have been completed, together with six cement rearing ponds ranging from 50 to 60 feet in length and 8 feet in width. These ponds are supplied with water from the wells by an open conduit. A foreman's cottage, a frame building 50 by 29 feet and containing eight rooms, has been built, the grounds have been fenced and graded, roadways begun, and shrubbery set out.

Owing to the exceptional advantages offered at Boothbay, Me., for the propagation of both lobsters and cod, it was decided to build and equip the station in the most modern and complete manner. The site is a rocky point of land, and stone quarried on the spot has entered largely into the construction of the new buildings, which are not only sub-

stantial but in keeping with their surroundings. On the property originally purchased are a seven-room frame dwelling, a small stable, and a storehouse, which, with some repairs, have all been utilized to good advantage. In July, 1903, the hatchery and a pumping plant were begun. The hatchery is a 1½-story frame structure on a heavy stone-and-concrete foundation. The main part is 70 by 48 feet, with an extension 18 by 11 feet on the north side, surmounted by a tower. Besides the hatching room, 66 by 44 feet, which when equipped will accommodate several hundred million lobster and cod eggs, the building contains a sleeping room, office, storage loft, closets, etc., is well lighted, has concrete floors, and is finished in natural wood. At a short distance from the shore has been built the pump house, circular in form and 22 feet in diameter. It is of heavy masonry to a height of 19½ feet, and supports a tower containing a cedar tank with a capacity of 7,500 gallons. Leading from the bottom of the pump well a suction pipe extends into the water to a point 2 feet below extreme low-water mark, and a 6-inch pipe from the pump house supplies the hatchery. Between the hatchery and the pump house is the boiler house, also of masonry, 31 by 30 feet. A frame storehouse and carpenter shop, 32 by 20 feet, has been built on the wharf, and a brick cistern is conveniently located near the buildings.

Owing to the severe Maine winter and the rocky character of the site, which necessitated much blasting, progress was necessarily slow, but at the close of the year the buildings were ready for machinery and equipment. Two boilers and two pumps have been purchased and are ready for installation. On July 2, 1904, there was added to the property a third parcel of land of 1⅛ acres, making a total area of about 10 acres. This purchase included a 2½-story frame dwelling, containing 11 rooms, which can be easily remodeled into a superintendent's residence.

At White Sulphur Springs, W. Va., good progress has been made toward completing the station, and fish-cultural operations are in progress on an extended scale. A residence has been constructed for the superintendent—a two-story building 53 feet square, erected on a brick foundation, containing 10 rooms and an attic, and heated by a furnace. Two stock ponds, respectively 0.45 and 0.24 acre in area and 5½ and 6 feet deep, have been completed, and a third one, nearly 0.3 acre in area, is well under way. Ten spawning ponds 66 by 12 feet, and six spawning ponds 20 by 8 feet, all from 2 to 2½ feet deep, have also been constructed. Lines of supply and waste pipes for the ponds have been laid, a wagon bridge has been built over Harpers Run, and the grounds have been graded and partly fenced.

Improvements for which special appropriations were made have been in progress at several stations, resulting in increased efficiency and economy of operation:

At Neosho, Mo., a 10-inch iron supply pipe has been laid in place of an old wooden conduit, and supply and distributing reservoirs, new troughs, machinery, and appliances were installed in the hatchery. Further improvements to the water supply are held in abeyance pending the acquirement of a right of way.

At Put-in-Bay, Ohio, the capacity of the hatchery has been increased by the purchase and installation of 760 additional hatching-jars, and iron supply tanks of a total capacity of 17,500 gallons have been substituted for the old wooden one. There have also been extensive repairs to the buildings and machinery.

At Duluth, Minn., the hatchery has been wired for electricity, 460 feet of the supply flume have been reconstructed, the crib well has been deepened, and material has been purchased for a new pipe line and reservoirs.

At Spearfish, S. Dak., sudden floods pouring down the canyon, at the mouth of which the station is situated, have caused much damage, and have necessitated the expenditure of considerable sums of money. The measures originally taken to prevent such damage having proved insufficient, an old protective channel has been excavated to a depth of 8 feet and a width of 15 feet, and walls have been constructed of solid masonry for a large portion of the distance, with retaining walls where necessary. Besides the danger of floods from the canyon, the lower part of the grounds, including the pond system, is subject to overflow from Spearfish Creek, and to guard against this, 90 feet of stone wall was built. This wall, however, with a new bridge, was washed away during the extreme high water last spring. The water supply has been increased by the erection of a new cement dam which will open up a series of springs near the head of the canyon, and the reservoir has been lowered 8 feet to accommodate this extra supply. Much grading about the grounds and reconstruction of roadways has been necessitated by these changes.

At the fish ponds in Washington, which are in the park system, much has been done toward beautifying and improving the grounds to bring them into accord with their surroundings, and this work is still in progress. The ponds have been altered to meet the present requirements, and the supply and waste-pipe system has been modernized. A triangular frame storage building 58 by 51 by 50 feet has been erected, containing much-needed workrooms and storerooms.

At Nashua, N. H., direct connection has been made with the city water system for protection against fire and to afford an emergency supply for the ponds, hatchery, and other buildings. Sewers have been laid, the piping system in the hatchery augmented, and all the buildings put in good repair.

At Northville, Mich., a series of 5 ponds, covering about 3 acres, has been sufficiently completed to allow the propagation of small-mouth bass

to be begun; the capacity of the hatchery for lake-trout eggs has been increased to 35,000,000 by the installation of more hatching troughs, additional pipe lines have been laid to the hatchery and ponds, and the drainage system has been enlarged.

At Bozeman, Mont., a hot water heating plant has been installed in the hatchery, and other needed improvements are being prepared for.

At Leadville, Colo., a 12-inch pipe line has been laid from Upper Evergreen Lake to the hatchery for the purpose of obtaining a new water supply, the former one not being sufficiently pure and being also subject to extreme changes of temperature.

OPERATIONS OF VESSELS.

Steamer Albatross.—On July 2, 1903, having on board the special commission to inquire into the conditions and needs of the Alaska salmon fisheries, the vessel left Port Townsend for southeast Alaska, where the investigation was begun at Boca de Quadra Bay. It was desired to visit as many of the fisheries as time would permit, and the itinerary embraced the island passages in the vicinity of Metlakahtla and Loring, and extended northward via Wrangell, through Stephens Passage and Lynn Canal, to Skagway, returning by way of Dundas Bay through Chatham and Peril straits to Sitka. Thence the vessel proceeded across the Gulf of Alaska to Afognak Island, Kadiak Island, and the Shumagin Islands, Chignik Bay, Yakutat Bay, and back to Sitka.

Shore parties visited canneries and salteries throughout the region under investigation, and examined the streams and lakes with reference to biological conditions as well as the commercial aspects of their fisheries, while dredgings and collections were made by the ship and important material and data were obtained in the shore and deeper waters. The Shumagin Islands were visited for the purpose of determining the desirability of inaugurating cod hatching at that point, and during a few days' delay at Skagway a party explored the headwaters of the Yukon for the purpose of making collections and gaining information respecting the ascent of salmon in that river. On the return voyage from Sitka a number of canneries omitted during the northern trip were inspected, the vessel reaching Seattle September 9 and San Francisco September 24. From that date until February 17 the vessel was in port, during which time repairs were made and an engine and boiler were installed in a new steam launch.

On February 17 the *Albatross* left San Francisco to take part in a study of the fishery resources of the California coast, instituted by the Bureau in cooperation with Leland Stanford University and the University of California. The end in view was the exploration and development of the fishing banks, and operations were carried on in the

vicinity of San Diego Bay, Cortez Banks, Santa Catalina Island, and Monterey Bay. The ship was continually engaged in collecting with intermediate and surface apparatus, and in making extensive dredgings and soundings about the regions under investigation. A line of dredgings was run 200 miles west from San Diego to the 2,000-fathom curve, and off Monterey to the 1,000-fathom curve. The work was brought to a close in June, and the vessel started for San Francisco, where she arrived on the 15th of the month.

Steamer Fish Hawk.—At the beginning of the year the *Fish Hawk* was undergoing repairs at Camden, N. J. These completed, she went to Woods Hole, Mass., arriving July 19, from which time until September 11 she was occupied with duties in connection with the biological laboratory of the Bureau, her work consisting chiefly of a systematic series of dredgings through Vineyard Sound between Nobska Point and Gay Head. At the close of the laboratory season the vessel sailed for Washington, going thence to Baltimore on October 8 for some minor refitting. She was engaged for a short period in the spring, beginning March 16, in the hatching of yellow perch at Chestertown, on the Chester River, Maryland, and on April 29 began the usual shad operations on the Delaware River, at Gloucester City, N. J.

Schooner Grampus.—This vessel was engaged from the beginning of the year until August 8 in collecting egg-bearing lobsters along the Maine coast to supply the hatchery at Gloucester, Mass. On October 5, after being docked and painted, she began the collection of brood codfish on the fishing grounds about Nantucket, No Man's Land, and Block Island, continuing until about the middle of November, when she was laid up for the winter and her crew detailed to assist in the collection of cod eggs for the Massachusetts hatcheries. In April the collection of lobsters for the present season was undertaken, and the vessel was thus engaged at the end of the year.

General.—Besides the usual minor repairs and renewals necessary to keep the smaller craft of the Bureau in good condition, more extensive alterations were made to some of the boats. The steamboat *Curlew*, attached to the Iowa station, was made more available for night work, which is often required, by the installation of electric light and searchlight, and by the extension of the deck house to afford sleeping quarters for the crew. A new boiler has been furnished the launch *Petrel*, and her machinery and hull have been thoroughly overhauled. New copper tanks have been put in the steamer *Phalarope*, and needed alterations have been made in the arrangement of engine room and cabin. Two new gasoline launches, 30 and 25 feet long, respectively, have been purchased, one for use at North McGregor, Iowa, in the collection of river fishes, and the other at Swanton, Vt., in extension of the sturgeon work.

INQUIRY RESPECTING FOOD-FISHES AND THE FISHING GROUNDS.

Attention is directed to the appended detailed report on the work of the division of inquiry respecting food-fishes and the fishing-grounds. This important branch of the Bureau deals with the biological questions which arise in connection with the economic fisheries and fish culture. It is particularly concerned with the exploration of lakes, streams, and salt waters; the study of the habits, growth, and distribution of fishes and other aquatic animals; the experimental cultivation of desirable products not now the objects of cultivation, with a view to developing methods that may be applied on a wholesale basis; the investigation of the diseases of fishes under cultivation and in a wild state, the pollution of waters in its effect on fish life, and the encouragement of biological research in the Bureau's laboratories and field operations.

The special commission for the investigation of the salmon fisheries of Alaska, to which reference was made in the last report of the Bureau, concluded its labors in the fall of 1903, and shortly thereafter a preliminary report was submitted, embodying the general results of the investigation and making recommendations for the protection and promotion of the fisheries. This report was forwarded to the Secretary November 13, 1903, by him presented to the President on January 21, 1904, and by the President transmitted to Congress on January 27, 1904, and printed as House Document No. 477, Fifty-eighth Congress, second session. The most important recommendations of the special commission are the establishment of government salmon hatcheries under the control of the Bureau of Fisheries, and the placing of all matters relating to the fisheries of Alaska under the direction of the Bureau.

Among the numerous special subjects which have been under consideration with reference to economic questions are the oyster, sponges, blue crab, diamond-back terrapin, green turtle, and various fishes. The experiments in the artificial fattening of oysters and the cultivation of sponges from cuttings have continued with satisfactory results. The raising of the diamond-back terrapin and the green turtle from the egg is receiving attention at points in Chesapeake Bay and on the coast of Florida. States in which inquiries have been made as to the fishery resources of particular waters are Maine, North Carolina, Indiana, California, and Arizona.

STATISTICS AND METHODS OF THE FISHERIES.

The work of the division of statistics and methods of the fisheries affords the only basis for determining the condition and trend of the commercial fisheries of the country; it is an invaluable criterion of the

necessity for and the results of fish-cultural operations of the government and states, and is indispensable in furnishing a basis for legislation.

The results of the inquiries in different regions with reference to the extent, condition, and methods of their economic fisheries, and of the investigation of special branches of the fishing industry to which attention has been given during the year are shown in the appended report of the assistant in charge. General canvasses have been conducted in the New England, South Atlantic and Gulf States, and the Hawaiian Islands, and special inquiries have been made into the condition of the vessel fisheries centering at Boston and Gloucester, Mass.; the fisheries of the interior waters of Florida; interior lakes and streams of New York and Vermont; the Pacific cod and halibut fisheries, and the whale fishery centering at San Francisco. There have also been very complete canvasses of the statistics and methods of the salmon industry of Washington, Oregon, California, and Alaska in conjunction with the work of the special salmon commission.

MISCELLANEOUS ADMINISTRATIVE AND OTHER MATTERS.

CHANGES IN PERSONNEL.

In the death of Mr. Cloudsley Rutter, which occurred November 28, 1903, the Bureau has lost the services of a very conscientious and efficient assistant. Mr. Rutter became connected with the Bureau in 1897 as scientific assistant, and at the time of his death was naturalist of the steamer *Albatross*. He took an active part in biological investigations on the Pacific coast, and his work on the salmon added much to the knowledge of the habits of those fishes. Mr. Rutter was succeeded by Mr. F. M. Chamberlain, general assistant on the *Albatross*.

The Bureau has lost another valued employee, Capt. S. J. Martin, whose death occurred June 10, 1904. Since 1888 he had rendered faithful service at his home in Gloucester, Mass., in collecting statistics of the important fisheries centering there.

Mr. William Barnum, an employee of the Bureau since 1891, and for many years editor of the Bureau's publications, resigned February 12, 1904, to take the position of chief clerk of the Carnegie Institution.

At the request of the minister of the Argentine Republic, transmitted through the Department of State, Mr. John W. Titcomb, assistant in charge of fish-culture, was granted leave of absence without pay for nine months beginning September 1, 1903, in order to make arrangements to inaugurate fish-cultural work on the part of the government of that country.

Mr. E. A. Tulian, for a long time superintendent of the hatchery at Leadville, Colo., resigned in order to take fish eggs to Argentina and

to accept permanent service with that government with the title national fish-culturist of the department of agriculture.

Mr. J. Frank Ellis, superintendent of the car and messenger service, was appointed assistant in charge of fish-culture for the period of Mr. Titcomb's absence.

On September 1, 1903, Mr. E. E. Hahn, who had served on the schooner *Grampus* since September, 1887, as mate and captain, was detached to take charge of the new station in course of construction at Boothbay Harbor, Maine. Captain Hahn was a thoroughly competent and efficient officer, a practical fisherman of great experience, a proficient fish-culturist, and his services on the *Grampus* have been invaluable to the Bureau. Mr. G. F. O. Hanson, first mate, was appointed to the command of the *Grampus*.

Mr. John N. Cobb, statistical field agent, resigned June 30, 1904, to accept the position of assistant inspector of salmon fisheries of Alaska.

PUBLICATIONS AND LIBRARY.

The demand for the publications of the Bureau is increasing yearly, and the supply of many of the bound volumes and pamphlets has become exhausted. Much of the matter printed by the Bureau is of permanent interest, and requests for special articles continue for years. The second edition of the very popular and useful "Manual of Fish Culture" has been entirely distributed, and a new edition, with revisions, is much needed. There have been sent out to regular recipients and on the application of Congressmen and others 1,797 bound volumes and 20,192 pamphlets.

During the year the bound volume of the Report for 1902 was issued, together with the following extracts in pamphlet form from the reports and bulletins for 1902 and 1903:

Description of a new genus and two new species of fishes from the Hawaiian Islands. By David Starr Jordan and Barton W. Evermann. Bulletin for 1902.
The fresh-water fishes of western Cuba. By Carl H. Eigenmann. Bulletin for 1902.
The organ and sense of taste in fishes. By C. Judson Herrick. Bulletin for 1902.
Rotatoria of the United States. II. A monograph of the Rattulidæ. By H. S. Jennings. Bulletin for 1902.
The plankton algae of Lake Erie, with special reference to the Chlorophyceæ. By Julia W. Snow. Bulletin for 1902.
Description of a new species of darter from Tippecanoe Lake. By William J. Moenkhaus. Bulletin for 1902.
Notes on some fresh-water fishes from Maine, with description of three new species. By William Converse Kendall. Bulletin for 1902.
Habits of some of the commercial cat-fishes. By W. C. Kendall. Bulletin for 1902.
A more complete description of Bacterium truttæ. By M. C. Marsh. Bulletin for 1902.
Report on collections of fishes made in the Hawaiian Islands, with descriptions of new species. By O. P. Jenkins. Bulletin for 1902.
The sponge fishery of Florida in 1900. By J. N. Cobb. Report for 1902.
Aquatic products in the arts and industries. By C. H. Stevenson. Report for 1902.
The utilization of the skins of aquatic animals. By C. H. Stevenson. Report for 1902.

List of the common names of the basses and sun-fishes. By Hugh M. Smith. Report for 1902.
The fisheries and fish trade of Porto Rico. By W. A. Wilcox. Report for 1902.
Statistics of the fisheries of the Middle Atlantic States. Report for 1902.
Records of the dredging and other collecting stations of the U. S. Fish Commission steamer *Albatross* in 1901–2. Report for 1902.
Isopods collected at the Hawaiian Islands by the U. S. Fish Commission steamer *Albatross*. By Harriet Richardson. Bulletin for 1903.
Birds of Laysan and the Leeward Islands, Hawaiian Group. By Walter K. Fisher. Bulletin for 1903.
Notes on a porpoise of the genus Prodelphinus from the Hawaiian Islands. By Frederick W. True. Bulletin for 1903.
Supplement to list of publications of the United States Fish Commission available for distribution. Report for 1902.
A catalogue of the shore fishes collected by the steamer *Albatross* about the Hawaiian Islands in 1902. By John Otterbein Snyder. Bulletin for 1902.
Notes on fishes collected in the Tortugas Archipelago. By David Starr Jordan. Bulletin for 1902.
Report of the Commissioner for the year ending June 30, 1903. By George M. Bowers.
Records of the dredging and other collecting and hydrographic stations of the U. S. Fisheries steamer *Albatross*. By Harry C. Fassett. Report for 1903.

The Museum of Comparative Zoology, Cambridge, Mass., has published as Volume XLIII of its Bulletin, "Reports on the Cephalopoda," by William E. Hoyle, based on collections made by the Fisheries steamer *Albatross* on its cruises to the west coast of Mexico, the west coast of Central America, and the Galapagos Islands, in 1891, and to the tropical Pacific Ocean in 1899–1900.

The library of the Bureau in Washington is gradually being made more complete in literature pertaining to fishing, fish-culture, aquatic biology, angling, oceanography, and related subjects. During the year the additions numbered 111 bound volumes and 369 unbound volumes and pamphlets. Excellent working libraries have been maintained at the laboratories at Woods Hole and Beaufort.

THE AMERICAN FISHERIES SOCIETY.

This representative society, composed largely of national and state officials devoted to the promotion of the fisheries, the cultivation of food and game fishes, and the protection of aquatic animals, met in annual session at the station of the Bureau of Fisheries at Woods Hole, Mass., July 21–23, 1903, George M. Bowers, United States Fish Commissioner, being president. An interesting series of papers was presented and discussed, and a prominent feature of the proceedings was the dedication of the memorial to Prof. Spencer F. Baird, provision for which was made by the society at its meeting at Woods Hole in 1901. The memorial consists of a large granite boulder with suitably inscribed bronze tablet, and was set up in a conspicuous place on the lawn of the Woods Hole station. Special exercises attended the unveiling and dedication of the memorial, and addresses were made by Prof. W. K. Brooks, Mr. E. W. Blatchford, Mr. Livingston Stone, and Mr. Frank N. Clark.

LOUISIANA PURCHASE EXPOSITION.

The exhibit of the Bureau at the Louisiana Purchase Exposition was duly assembled and installed under the direction of Mr. W. de C. Ravenel, representative on the government board, and was fully completed when the exposition was formally opened on April 30, 1904. Although Mr. Ravenel had not been connected with the Bureau since February, 1902, he was, with the approval of the Secretary, asked to continue as representative until the close of the exposition, in view of his efficient services and his familiarity with exposition methods.

The Bureau's exhibit occupies a separate building, adjacent to the main government building, and is a more complete and attractive display of the kind than has heretofore been made. The aquarium, which is particularly complete in equipment and pleasing in design, has proved one of the leading features of the exposition.

APPROPRIATIONS.

The appropriations for the Bureau of Fisheries for the fiscal year 1904 were as follows:

Salaries	$250,140
Miscellaneous expenses:	
Administration	12,500
Propagation of food-fishes	200,000
Inquiry respecting food-fishes	22,500
Statistical inquiry	7,500
Maintenance of vessels	45,000
For the establishment of a new station at Mammoth Spring, Ark	25,000
For the purchase of additional land, for improvements, and for completion of stations at—	
Boothbay Harbor, Me	10,000
White Sulphur Springs, W. Va	10,000
Neosho, Mo	12,500
Put in Bay, Ohio	7,500
Duluth, Minn	2,000
Spearfish, S. Dak	10,000
For improvements and completion of stations at—	
Fish ponds, Washington, D. C	7,000
Nashua, N. H	5,000
Erwin, Tenn	6,000
Northville, Mich	5,000
Bozeman, Mont	3,500
Leadville, Colo	3,800
For repairs to steamer *Albatross*	28,000
For purchase of two launches	2,000

A report of expenditures under these appropriations will be made in accordance with law.

GEORGE M. BOWERS,
Commissioner.

REPORT ON THE PROPAGATION AND DISTRIBUTION OF FOOD FISHES.

By John W. Titcomb, *Assistant in Charge.*

GENERAL RESULTS.

The usual work of propagation and distribution of food fishes was prosecuted during the past fiscal year, 44 species receiving attention at the various hatcheries; many of these species and four or five additional were collected from the overflowed lands of the Mississippi and Illinois rivers; and the lobster also was propagated. The total output was 1,267,334,385 fish and eggs, exceeding that for all previous years except 1902.

The total output maintains a more or less constant increase from year to year, but the results from any particular branch of fish cultural work necessarily vary, owing to seasonal conditions. Shad operations were prosecuted with the same energy as heretofore, but in spite of all possible efforts there was a marked decrease in the number of eggs collected at every station. At Bryan Point this was somewhat compensated for by the fact that the yellow perch work, conducted at the same time, was attended with very good success, over 23,000,000 young perch being hatched and planted in the Potomac River. At Gloucester, N. J., on the Delaware River, where the *Fish Hawk* was engaged in the collection of shad eggs, the season was especially poor for the commercial fishermen and but few ripe shad were caught. The natural spawning grounds on the Delaware appear to have undergone an entire change, and Howells Cove, one of the best spawning grounds on the river a few years ago, which yielded in 1901 nearly 50,000,000 eggs, produced the past season 344,000. At Edenton, N. C., the shad season was the most unsuccessful in point of egg collections since the establishment of the station. At Battery station, Maryland, at the mouth of the Susquehanna River, about the average number of eggs was taken, the output being 37,397,000 eggs and fry. The total product of this station was materially augmented by the hatching and distribution of 29,850,000 white perch.

The salmon work on the Pacific coast was unusually successful. At Baird, Cal., all previous records were exceeded, the total output, including that of the auxiliary stations, being 66,948,484 eggs and fry. Even more eggs might have been collected had it been possible to secure sufficient men to do the work. The results at Clackamas, Oreg., and its substations likewise exceeded those of all previous years, and the output of Baker Lake station, in Washington, with its substation at Birdsview, was more than double that of any year in its history. The Baker Lake station is the only one where the blueback salmon can be propagated.

A marked change in sentiment in regard to the artificial propagation of salmon is noted among the Pacific coast salmon fishermen and packers, who are reluctantly yielding their prejudice, and it is interesting to note that fishermen who refuse to acknowledge the beneficial effects of the work are frequently found basing their plans upon the run of fish expected as the result of certain plants made from the hatcheries. It appears that a few years ago they depended very largely upon the July run as the mainstay of their business, the August run furnishing a flabby and inferior fish. In the past two years there has been a small July run, and the increasing run through August and into September has been of the same quality as were the fish which formerly were taken in July. The fishermen, therefore, believe that the change has been brought about by artificial propagation, and go into considerable detail to follow out their reasoning.

The striped bass work, taken up experimentally during the fiscal year 1903 at Weldon, N. C., with such encouraging results, was conducted on a much larger scale and with sufficient success to warrant extending the field of operations, if it is possible to find places where spawning fish can be obtained in sufficient numbers. For the purpose of collecting eggs from fish caught by local fishermen, 9 field camps were established along the banks of the Roanoke River between Roanoke Rapids and Halifax, N. C., a distance of nearly 20 miles. Although the run of fish is said to have been several times smaller than was ever before known, the results were most satisfactory, a total of 13,683,000 eggs being taken and yielding 7,219,000 fry. The output of the station was not as large as was anticipated, there being a loss of fry due to the fact that certain features of the hatching apparatus were special and not fully perfected when the operations began. The defects were remedied as soon as discovered, however, and another season no such loss will occur.

The output of Atlantic salmon depends very largely upon the amount of money invested in adult fish, within the limits of the market supply. At the Craig Brook station in Maine the salmon obtained by purchase from the owners of the various weirs in the towns of Verona and Penobscot during the preceding June and retained until ripe produced

3,484,000 eggs and were then liberated. The feature of this work to be noted is that it is evident the commercial salmon fishery on the Penobscot is maintained entirely by artificial propagation, few, if any, of the adult fish being able to escape the weirs and reach the natural spawning grounds. Most of the eggs taken for the hatchery, after being sufficiently developed to bear the journey, the last 18 miles of which was made on sleds, were transferred to a substation recently established for this purpose at Little Spring Brook, on the upper Penobscot River, and the fry were scattered in the east branch of that stream. In other words, the distribution, which has heretofore been effected by transporting the fry in cars, was made this year practically in the form of eggs, the special object of the change being to hatch and plant the young fish at points much nearer their natural home in the headwaters of the river than is possible when they are hatched at Craig Brook. Here the parent fish would undoubtedly have spawned had they been able to pass the many devices set for their capture in the lower reaches.

The importance of establishing a subsidiary station on the upper Penobscot was regarded as paramount to the operating of the Grand Lake Stream station, where eggs of the landlocked salmon are collected. As a result, there was a falling off in the total output of landlocked salmon, but the Green Lake station produced a large quantity of this valuable species. The demand for landlocked salmon within the limits of Maine, where nearly all the eggs are collected, and also in other States where this fish has been successfully acclimatized, exceeds the supply, and an attempt will be made to increase the output during the coming year.

Although cod propagation was prosecuted vigorously, the results were extremely unsatisfactory. The exceedingly cold and stormy weather, together with the scarcity of fish from the inshore fisheries, offset the efforts of the collecting force, and many of the commercial fishermen found it not worth while to keep their boats in commission.

At Woods Hole the collection of eggs of the winter flounder was not undertaken at the usual season because the fishing grounds were covered with ice. When the ice disappeared, it was found that the low water temperatures had retarded the spawning of the fish for a month, and the season's work in this branch was very satisfactory.

At the end of the season several small lots of pollock eggs were received, which produced 1,246,000 fry.

The following innovation in lobster culture is worthy of note: As an experiment, 7,081 seed lobsters were impounded and retained throughout the winter. In the spring, although only 4,748 remained, all of these produced eggs except 630. The pound was leased with the idea that the Boothbay hatchery would be ready to receive the eggs, but it became necessary to transfer the fish-cultural operations to Gloucester

temporarily, and as a result the Gloucester station was enabled to distribute 97,200,000 lobster fry, the largest product of this species in the history of the station. While the mortality among the lobsters in the pound was great, the unusually severe winter was particularly unfavorable for the experiment, conducted as it was in a small shallow pound. Persons in Portland and Boston who impound lobsters on the coast of Maine reported an unusually heavy loss in stock and attributed it to the intensely cold and stormy weather.

More than three-fourths of the lobsters impounded for this experiment were of Nova Scotia origin. During the spring months the Maine lobster dealers send both sailing and steam smacks to Nova Scotia to secure cargoes, and this work is continued until June, when interrupted by the close season in Nova Scotia. Upon arrival on the Maine coast nearly all of the lobsters are impounded and held for the high prices of the summer trade, and as they lay their eggs while confined in the warm water of these inclosures, large numbers of egg-bearing lobsters are taken out. The stock for this experiment was obtained at the time the impounded stock of the fishermen was transferred preparatory to being marketed.

In making the collection of lake-trout eggs in Lakes Superior and Michigan the extremely cold weather and high winds prevailing the greater part of the season frequently prevented the lifting of nets for several days in succession, and considerably reduced the quantity of eggs collected. Many of the eggs became water hardened before they were fertilized, while others were frosted in the spawning tanks. Another obstacle to the success usually attending this work was the interference of the Michigan game warden, who claimed the right to supervise the Bureau's operations during the close season. It is the practice to employ tugs, engaged in commercial fishing, for the purpose of collecting spawning fish in these waters, and in the controversy the work of these tugs was interrupted for several days. The question was appealed to the courts, which enjoined further interference on the part of the game warden; but the time lost was sufficient to materially affect the quantity of eggs taken.

It is necessary to record also that the output of white-fish on the Great Lakes was much below that of the two previous years. On the other hand, this shortage is largely compensated for in the fact that the output of pike perch exceeded that of any previous year in the history of the Bureau, Put-in Bay station alone producing 244,275,000 eggs and fry.

The work of propagating the small-mouthed black bass, begun last year, has been continued experimentally at several stations with very encouraging results, and it is believed it will be possible another year to meet all demands for this very desirable game fish. Its propagation has now been taken up at Northville, Mich.; White Sulphur

Springs, W. Va.; Wytheville, Va.; Cold Springs, Ga.; Erwin, Tenn., and to a small extent at St. Johnsbury, Vt., the waters at all of these points having proved congenial. At some of these stations the large-mouth black bass also was propagated, and at the San Marcos, Cold Springs, Wytheville, and Northville stations the output of both species exceeded that of any previous year. The Tupelo, Miss., station has not yet been completed, but sufficient ponds were constructed to allow of the production and distribution of 13,500 fingerling bass of the large-mouthed species.

The propagation of the eastern brook trout, black-spotted trout, and rainbow trout was conducted on the same lines as heretofore, the output exceeding that of past years. In this connection the stations at Leadville, Colo., and Spearfish, S. Dak., are worthy of special mention, the product of each being far in excess of that of any previous year.

The usual exhibit of fish and other aquatic animals was maintained in the Central Station aquarium, at Washington, D. C., and, although small, continued to be attractive to a large number of visitors daily. In addition, the hatching of shad and various species of trout was conducted on a small scale for exhibition purposes.

ACCLIMATIZATION OF FISH.

The waters in the Black Hills of South Dakota were originally devoid of trout, but they now afford a source for the collection of eggs and contribute to the output of the Spearfish station, though the bulk of the black-spotted trout produced at this station is derived from eggs taken at a subsidiary station in Yellowstone Park. The waters of Colorado furnish another illustration of the successful acclimatization of fish, in the fact that the eastern brook trout has become so firmly established there that it is now possible to collect more eggs of this species from the natural streams and ponds at the subsidiaries connected with the Leadville station than are collected from any station in the east, where the fish is native.

The demand for rainbow trout has exceeded the supply in some parts of the country where its introduction has been especially successful. It is frequently called for by applicants who want it because it is different from the native species, and it is a favorite for acclimatization in foreign lands. Not far from Paris, France, is a large commercial hatchery devoted entirely to the propagation of rainbow trout, the annual product being 100,000 fish of market size, besides the sale of eggs and alevins for stocking preserves. In some states the acclimatization has not been successful, and this is particularly true of the waters of New England, where many plants have been made and have resulted in the production of only a few adult fish. With the exception of some lakes in Massachusetts, it is not known that the rainbow

trout has obtained a sufficient foothold in any New England waters to maintain itself by natural reproduction. Enduring as it does a somewhat higher temperature than the native trout, it was hoped it would succeed in waters which, owing to deforestation or other causes, have become unsuited to the latter.

The successful acclimatization of the steelhead trout in Lake Superior and other inland waters makes it desirable to propagate this species on a larger scale. The latest reports from Lake Superior give information that the steelheads spawned last spring in nearly all of the tributary streams along the north shore of the lake.

The landlocked salmon has been successfully introduced in several ponds in Maine where it is not indigenous, and in Pierce Pond with marked results. This pond is 9 miles long, about three-fourths of a mile in width, and over 100 feet deep in places, and is practically landlocked. The plant was made eight years ago and forgotten until the summer of 1903, when one specimen was caught weighing 16½ pounds, one 14 pounds, several 12 pounds, and some 9 and 7 pounds. Quite a number weighing 5 pounds were caught, and these were the smallest taken. When the above information was received, these salmon were said to be quinnats, the result of plants made nine years ago, but an investigation has demonstrated that the introduction of the quinnat salmon proved a failure. It would be interesting to learn the results of a similar investigation of the reported success in acclimatization of quinnat salmon in certain fresh-water lakes in France.

FISH-CULTURAL NOTES.

In addition to the regular work of propagation, fish-cultural experiments have been conducted at various points.

It being a recognized fact that landlocked salmon from Green Lake, Maine, have a much greater average weight than those from Grand Lake Stream, it was determined to compare the rate of growth by carrying through the season at the Craig Brook station parallel series of fish from these waters. It was shown that under similar conditions, and with the same water supply for a given length of time, landlocked salmon of Green Lake grew more rapidly than those of Grand Lake Stream; the Green Lake fish also showed greater endurance, there being a smaller mortality among them than among the Grand Lake Stream lot.

For observation and experiment in the domestication of landlocked salmon, one brood hatched from the eggs of 1899 was maintained in the most capacious pond available, and a special study was made of the development of the reproductive organs and the character of the offspring. The lot comprised 173 fish, confined in a pond with an area of 45 by 60 feet and a mean depth of about 6 feet, and in Novem-

ber, 1903, they yielded 9,000 eggs, from which 4,930 fry were hatched in April and May. The parent fish had been dieted several months preceding their spawning, being fed very sparingly for a time and at last subjected to a lengthy fast, but this did not suffice to insure prime quality in the eggs, which distinctly lacked normal vigor. It has been suggested that to secure good results it may be necessary to supply a more natural food than the hogs' plucks, on which the fish have subsisted all their lives. Another brood of landlocked salmon hatched in 1901 is held to secure data as to the comparative rate of growth and eventual size of fish derived from Grand Lake Stream and Lake Auburn.

A small number of albinos was discovered among the landlocked salmon hatch of 1903, and at the end of the year these fish were apparently healthy and vigorous, 25 remaining out of the original 28.

At the Baker Lake station, in Washington, it has always been a very difficult matter to trap the fish which pass through the lake and ascend the tributary streams to spawn, owing to the fact that these tributary streams are of glacial origin, flow through a narrow gorge, and are subject to such tremendous floods that no fish racks can withstand them. Upon the recommendation of the superintendent a trap similar to that used on Puget Sound was conveyed in sections over a pony trail to the lake, put together, and set up in a depth of from 1 to 60 feet at low water, the piling and webbing being made 15 feet above low-water mark to insure the capture of fish during high water. It was set at the outlet of the lake, and although not installed before the run of fish had begun, its practicability was demonstrated and the product of the station was doubled. Still greater results may be expected the coming season.

As the fish were caught when entering the lake, most of them were unripe. Two inclosures were therefore constructed for holding the unripe fish—one of webbing and piles 100 feet wide by 200 feet long, with an average depth of 6 feet during low water; for the other a slough which flows into the lake was utilized. This slough has a large and constant, though very sluggish, flow of water through it, and contains deep holes. There was no apparent difference in the quality of the eggs, but the fish held in the former inclosure were continually working against the webbing and became more or less fungused. This was especially noticeable among the male fish, many of which became caught in the webbing by their teeth. The fish in the slough inclosure lay quietly in the deep holes, making no effort to escape, and were in perfect condition at the time of spawning. Many of the fish were thus held for two months, and there was no apparent difference between their eggs and the eggs of those which were found ripe and stripped immediately after being caught. This is the first occasion on which

the Bureau has been successful in the penning of the Pacific coast salmon for an extended period, but it must be borne in mind that the water at Baker Lake is always at a much lower temperature than the water at any other station where salmon operations are conducted.

The method of killing and bleeding the fish by cutting off their tails before taking the spawn has been adopted at this station, and the use of a normal salt solution for washing the eggs has not been found necessary if the fish are properly bled.

The method of taking spawn at the Clackamas hatchery and its substations was similar to that of previous years, but several experiments were tried to test the efficacy of bleeding the fish prior to taking the eggs, and the advantage of this method, if any, over the use of a normal salt solution for washing the eggs. Experiments were also made to determine whether or not eggs should be washed before they are transported. A million eggs were taken by killing the fish and extruding the eggs by hand pressure; the eggs were then washed and fertilized, and they hatched with a loss of 10.6 per cent. Six hundred and eleven thousand eggs were taken by killing the females, bleeding by cutting off the tail, pressing the eggs out by hand, and washing them with a normal salt solution. This lot hatched with a loss of 18.7 per cent. Two million six hundred and fifty thousand eggs were taken by killing the fish, bleeding them by cutting off the tail, pressing the eggs out by hand and fertilizing without washing. These hatched with a loss of 9.9 per cent. Seven hundred and fifty-four thousand eggs were taken from fish which were killed and not bled, the eggs being taken by incision and washed in a normal salt solution before being fertilized. The loss in this case was 3.8 per cent. Two million five hundred and ninety-three thousand eggs were obtained by killing and bleeding the females, then taking the eggs by incision and washing without the use of the normal salt solution. The loss in hatching amounted to 1.5 per cent. Six hundred and nine thousand eggs were taken by killing and bleeding the fish, taking the eggs by incision, and washing in a normal salt solution. These hatched with a loss of 2.02 per cent. One hundred and seventy-six thousand eggs were taken by incision after killing and bleeding the fish, and washed in a normal salt solution. These hatched with a loss of 1.9 per cent. The experiments were not concluded.

A large number of young salmon, the product of eggs obtained at various substations, were reared to the fingerling stage and marked before being liberated. The adipose fin was removed on all, and in order to identify the different lots the fish hatched at Clackamas were given an additional mark by removing the anterior portion of the dorsal fin. The posterior half of the dorsal fin was removed from the fish produced at Little White Salmon, the anterior half of the anal

from those from Mill Creek, California, and the posterior half of the anal fin on the ones from Rogue River. Some of the fish first marked were held over three weeks before being liberated, and their health did not seem at all affected by the mutilation.

Experiments at the Rogue River station, in Oregon, indicate that green eggs can best be transported over the rough roads by transferring them to canton flannel trays before the milt has been washed from them.

At the Bozeman station the superintendent continued his experiments in the artificial feeding of grayling fry. Blood was last year regarded as the most desirable food for young fry, and this season's work has confirmed that belief. When the fry were placed in the nursery ponds it was observed that they picked off the small organisms lodged there, and, in imitation of the natural conditions, bunches of water cress dipped in blood and liver emulsion were suspended in the hatching troughs for the fry to feed upon. This device having proved fairly successful, it was adopted in the nursery ponds, which, being supplied with creek water, contained also small crustaceans and other natural food.

At the Wytheville, Va., station some experiments have been made to test the merits of azotine, a stockyards preparation, in comparison with liver as food for trout. By way of preparation the azotine was mixed with wheat middlings in equal parts, cooked into a mush, and before feeding was pressed through a screen. The preparation is nutritious, but unsuited to the delicate stomachs of small fry. After the fish are two or three months old it appears to agree with them when given alternately with liver. The experiments have not been conclusive.

It was noticed at the Put-in Bay station that the eggs of pike perch which were placed on the batteries where they received the most light and sunshine hatched in less time than those situated in the darker part of the house; it was also noticed that those hatching in the shortest time produced the greatest percentage of fry. No direct experiment was made along these lines, but the difference was sufficient to attract the attention of the superintendent.

It is reported by Mr. Alex. Herbster, of Put-in Bay, that a pike perch weighing about 8 pounds, in ripe spawning condition, was caught by him with hook and line through the ice on January 14. The earliest previously recorded date for the spawning of pike perch in Lake Erie is in the month of April.

In the striped bass work at Weldon, N. C., the smallest yield of eggs was 14,000 from a 3-pound fish, and the largest was 3,220,000 from one of 50 pounds. The largest yield of eggs previously recorded is 2,200,000 from a fish whose weight is not given. It is reported that there is an early and a late run of striped bass, with color

markings and shape so different that all experienced fishermen can easily distinguish them, the two runs being known as "long rock" and "short rock," respectively.

On the 1st of April, 2,770,000 eggs were taken from a flat-fish caught in Woods Hole Harbor. The fish was 18 inches long, 10 inches wide, and weighed 3½ pounds after being stripped. The greatest number previously recorded as having been taken from one fish is 1,462,000, from an individual of about the same size.

The impounding of lobsters throughout the winter was not only a success in the increased product of young lobsters, but it was noticed that the eggs from the impounded lobsters were more fully developed when taken from the pound than were the eggs of lobsters collected elsewhere at about the same time. The eggs began hatching May 21, fully a week earlier than in any previous season, and three weeks earlier than the other lobster eggs on hand at the same time. The eggs from the impounded lobsters also revealed a more uniform development than the others, quite 75 per cent of these hatching before the others had begun to hatch in any quantity. There were also remarkably few bad eggs, the loss being estimated at not over 2 per cent, while the loss in the eggs from other sources ran from 6 to 10 per cent. The greater maturity of the impounded product, as well as the more uniform development, can be accounted for by the fact that these lobsters were in a shallow pound where the water would naturally be of a higher temperature than the deeper waters of the ocean, from which the other lobsters were obtained. The same course of reasoning holds good only indirectly in accounting for the superior quality of the eggs.

OPERATIONS OF THE STATIONS.

The stations and substations at which fish-cultural operations were conducted in 1904, with the persons in charge, are shown in the appended statement. The subsidiary stations mentioned have regularly established plants for the conduct of fish-cultural operations, and in some instances are more productive than the permanent stations with which they are connected; none is provided with a personnel, all being operated under the direction of the superintendents of the stations with which they are respectively connected. It is customary to detail some one from the personnel of the regular station to assume direct charge while operations are being conducted at the substation. Several temporary field stations are annually operated from some stations, but these are not given in the following list. In such cases the work is of short duration, with few, if any, permanent fixtures. For illustration, collections of landlocked salmon and brook trout eggs are annually made at several field stations connected with the Green Lake station in Maine; for the St. Johnsbury station large

collections of brook trout eggs are made at three small subsidiary stations operated simply during the spawning season and until the eggs are sufficiently well developed to bear transportation to St. Johnsbury.

Stations and substations operated in 1904.

Name and location.	Superintendent.
Green Lake, Me	E. E. Race.
Craig Brook, East Orland, Me	Charles G. Atkins.
Upper Penobscot, Me.	
Nashua, N. H	W. F. Hubbard.
Sunapee Lake, N. H.	
St. Johnsbury, Vt	E. N. Carter.
Swanton, Vt.	
Gloucester, Mass	C. G. Corliss.
Woods Hole, Mass	E. F. Locke.
Cape Vincent, N. Y	Livingston Stone.
Steamer Fish Hawk	J. A. Smith, commanding.
Battery, Havre de Grace, Md	Alexander Jones.[a]
Bryan Point, Md	R. W. Owens.
Central Station, Washington, D. C	John E. Brown.[a]
Fish Lakes, Washington, D. C	C. K. Green.
Wytheville, Va	George A. Seagle.
White Sulphur Springs, W. Va	R. K. Robinson.
Erwin, Fishery, Tenn	Alexander Jones.
Cold Springs, Bullochville, Ga	J. J. Stranahan.
Tupelo, Miss	C. P. Henkel.[a]
Edenton, N. C	S. G. Worth.
Weldon, N. C.	
Put-in Bay, Ohio	S. W. Downing.
Northville, Mich	Frank N. Clark.
Detroit, Mich.	
Sault Ste. Marie, Mich.	
Charlevoix, Mich.	
Alpena, Mich.	
Duluth, Minn	S. P. Wires.
Quincy, Ill	S. P. Bartlett.
Manchester, Iowa	R. S. Johnson.
Bellevue, Iowa.	
North McGregor, Iowa.	
Neosho, Mo	H. D. Dean.
San Marcos, Tex	J. L. Leary.
Leadville, Colo	E. A. Tulian, W. T. Thompson.
Grand Mesa Lakes, Colo.	
Spearfish, S. Dak	D. C. Booth.
West Thumb, Yellowstone Park.	
Bozeman, Mont	James A. Henshall.
Baird, Cal	G. H. Lambson.
Battle Creek, Cal.	
Mill Creek, Cal.	
Clackamas, Oreg	Claudius Wallich.
Little White Salmon, Wash.	
Big White Salmon, Wash.	
Rogue River, Oreg.	
Eagle and Tanner creeks, Oreg.	
Baker Lake, Wash	Henry O'Malley.
Birdsview, Wash.	

[a] In charge.

Fish and eggs furnished for distribution by the stations of the Bureau of Fisheries during the fiscal year 1904.

Station and name of species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Green Lake, Me.:[a]			
Landlocked salmon	122,500	18,000	318,800
Brook trout	50,000	1,013,065	
Craig Brook, Me.:[a]			
Landlocked salmon		772	28,200
Atlantic salmon	25,500	2,566,716	369,000
Brook trout		313,665	82,300

[a] In addition to the above, the following transfers of fish and eggs were made:
From Green Lake to other stations, 37,000 landlocked salmon eggs.
From Craig Brook to Nashua for rearing, 48,785 brook trout fry.
From St. Johnsbury to Craig Brook, 400,000 brook trout eggs; to Nashua, 75,000 brook trout fry for rearing to fingerlings.

Fish and eggs furnished for distribution by the stations of the Bureau of Fisheries during the fiscal year 1904—Continued.

Station and name of species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Nashua, N. H.:			
Landlocked salmon			27,650
Brook trout		348,000	99,424
Rainbow trout			10,824
Lake trout		74,000	
Golden trout		36,000	30
Canadian red trout			13
Grayling		40,000	
St. Johnsbury, Vt.:[a]			
Landlocked salmon			23,190
Brook trout	50,000	1,239,287	
Rainbow trout			27,000
Steelhead trout			36,380
Lake trout		85,000	
Small-mouth black bass			1,392
Swanton (substation), Vt.:[a]			
Pike perch	5,000,000	31,585,000	
Gloucester, Mass.:			
Cod		35,366,000	
Flat-fish		124,615,000	
Pollock		1,246,000	
Lobster		97,200,000	
Woods Hole, Mass.:			
Cod		44,079,000	
Flat-fish		103,657,000	
Mackerel		324,000	
Lobster		9,682,000	
Cape Vincent, N. Y.:			
Landlocked salmon		9,200	
Brook trout		1,198,600	
Rainbow trout		42,000	
Lake trout		4,470,000	
White-fish		14,800,000	
Pike perch		100,000	
Steamer Fish Hawk:			
Shad	45,000	5,454,000	
Battery, Md.:[a]			
Shad	6,964,000	29,245,000	
White perch		29,850,000	
Striped bass		200,000	
Fish Lakes, Washington, D. C.:			
Black bass			46,874
Crappie			7,812
Cat-fish			900
Central Station, Washington, D. C.:			
Brook trout		54,000	
Rainbow trout		6,150	
Shad		2,032,000	
White-fish		435,000	
Pike perch		2,499,000	
Bryan Point, Md.:[a]			
Shad	1,600,000	27,397,000	
Yellow perch		23,238,000	
Wytheville, Va.:[a]			
Brook trout		10,000	114,485
Rainbow trout	20,000	75,100	107,060
Steelhead			12,000
Black bass			42,097
Rock bass			7,425
White Sulphur Springs, W. Va.:			
Brook trout		413,000	38,748
Rainbow trout		112,383	18,980
Erwin, Tenn.:			
Brook trout			39,800
Rainbow trout			53,765

[a] In addition to the above, the following transfers of fish and eggs were made:
From Green Lake to other stations, 37,000 landlocked salmon eggs.
From Craig Brook to Nashua for rearing, 48,785 brook trout fry.
From St. Johnsbury to Craig Brook, 400,000 brook trout eggs; to Nashua, 75,000 brook trout fry for rearing to fingerlings.
From Swanton to Cape Vincent, 4,050,000 pike-perch eggs.
From Battery to Central Station, Washington, D. C., 1,188,000 shad eggs for hatching.
From Bryan Point to Central Station, 200,000 shad eggs.
From Wytheville to other stations, 360,000 rainbow-trout eggs.

Fish and eggs furnished for distribution by the stations of the Bureau of Fisheries during the fiscal year 1904—Continued.

Station and name of species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Erwin, Tenn.—Continued.			
Black bass			2,235
Rock bass			6,970
Bream			15,258
Cat-fish			4,413
Cold Springs, Ga.:			
Black bass			202,800
Crappie			150
Warmouth bass			6,520
Bream			20,660
Cat-fish			8,975
Tupelo, Miss.:			
Black bass			13,500
Edenton, N. C.:			
Shad	4,560,000	1,728,000	
Weldon (substation), N. C.:			
Striped bass		3,698,000	
Put-in Bay, Ohio: [a]			
Lake trout		884,000	
White-fish	46,280,000	53,250,000	
Lake herring		23,300,000	
Pike perch	82,000,000	139,275,000	
Northville, Mich.: [a]			
Brook trout		830,000	15,000
Rainbow trout		60,000	28,000
Steelhead trout		9,500	49,040
Loch Leven trout		138,000	42
Lake trout	3,010,000		
Small-mouth black bass			15,000
Detroit (substation), Mich.: [a]			
White-fish	14,035,000	28,000,000	
Pike perch	22,495,000	2,300,000	
Alpena (substation), Mich.:			
Lake trout		2,250,000	
White-fish		30,000,000	
Charlevoix (substation), Mich.:			
Lake trout		2,500,000	
White-fish		30,000,000	
Sault Ste. Marie (substation), Mich.:			
Lake trout		1,000,000	
White-fish		10,000,000	
Duluth, Minn.: [a]			
Brook trout		17,000	
Rainbow trout		13,400	
Steelhead trout			48,000
Lake trout	50,000	7,155,000	10,000
White-fish		10,000,000	
Pike perch		3,850,000	
Quincy, Ill.:			
Black bass			49,577
Crappie			15,550
Bream			2,865
Cat-fish			2,052
Manchester, Iowa: [a]			
Brook trout	100,000	156,000	14,950
Rainbow trout	188,500	55,000	116,451
Steelhead trout			10,100
Black-spotted trout			28,000
Loch Leven trout			73
Lake trout			174
Landlocked salmon			100
Quinnat salmon			150
Pike perch		2,100,000	
Yellow perch		25,000	
Rock bass			2,250
Bellevue (substation), Iowa:			
Black bass			9,870
Crappie			2,300
Cat-fish			1,500

[a] In addition to the above the following transfers were made:
From Put-in Bay to other stations, 23,000,000 pike-perch eggs.
From Northville to other stations, 3,305,000 lake-trout eggs.
From Detroit to other stations, 25,980,000 white-fish eggs.
From Duluth to Cape Vincent, 2,793,250 lake-trout eggs.
From Manchester to other stations, 50,000 brook-trout eggs and 421,000 rainbow-trout eggs

Fish and eggs furnished for distribution by the stations of the Bureau of Fisheries during the fiscal year 1904—Continued.

Station and name of species.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Neosho, Mo.:[a]			
Landlocked salmon			18
Quinnat salmon			3,975
Rainbow trout	500	37,000	70,075
Steelhead trout			25
Grayling			26
Black bass			11,355
Strawberry bass			2,530
Rock bass			29,530
San Marcos, Tex.:			
Black bass			127,625
Crappie			1,079
Strawberry bass			200
Rock bass			9,109
Bream			1,452
Cat-fish			597
Leadville, Colo.:[a]			
Brook trout	341,000	1,074,000	318,840
Rainbow trout	5,000	5,000	42,016
Steelhead trout			8,000
Black-spotted trout	4,000		3,923,634
Grayling		50,000	9
Loch Leven trout			18
Lake trout			33
Spearfish, S. Dak.:[a]			
Brook trout		442,000	1,577
Rainbow trout		2,000	9,000
Loch Leven trout		44,500	2,158
Black-spotted trout	425,000		2,117,000
Bozeman, Mont.:[a]			
Brook trout			94,800
Rainbow trout			40,300
Steelhead trout			55,000
Black-spotted trout	40,000		548,000
Lake trout			2,000
Grayling	334,000	2,553,650	225
Baird, Cal.:			
Quinnat salmon	27,352,850	2,350,130	
Battle Creek (substation), Cal.:			
Quinnat salmon	21,354,255		
Mill Creek (substation), Cal.:			
Quinnat salmon	15,891,249		
Clackamas, Oreg.:			
Quinnat salmon	3,113,000	6,247,247	
Landlocked salmon			13,470
Brook trout		206,069	24,170
Rainbow trout		64,132	7,692
Steelhead trout		15,132	11,090
Black-spotted trout		10,620	36,010
Lake trout		80,280	31,626
Grayling		48,550	
Little White Salmon (substation), Wash.:			
Quinnat salmon	5,287,000	10,426,000	
Big White Salmon (substation), Wash.:			
Quinnat salmon	2,219,000	5,950,800	
Eagle and Tanner creeks (substation), Wash.:			
Quinnat salmon		938,500	
Rogue River (substation), Oreg.:			
Quinnat salmon		9,023,428	
Steelhead trout		8,073	
Black-spotted trout		8,695	
Baker Lake, Wash.:[a]			
Steelhead trout	161,000	70,000	
Quinnat salmon		70,883	
Blueback salmon		3,855,000	
Silver salmon		3,984,645	
Humpback salmon		176,597	

[a] In addition to the above the following transfers were made:
From Neosho to other stations, 141,400 rainbow-trout eggs.
From Leadville to other stations, 350,000 brook trout eggs and 95,000 black-spotted trout eggs; 100,000 rainbow-trout eggs, which were sent to the Argentine Republic, were acquired by exchange with the Colorado Fish Commission, and are not included in the above tabulation.
From Spearfish to Central Station, Washington, D. C., 20,000 black-spotted trout eggs.
From Bozeman to other stations, 160,000 grayling eggs and 20,000 black-spotted trout eggs.
From Baker Lake to other stations 94,000 steelhead-trout eggs.

DISTRIBUTION.

In the distribution of fish it is the general policy of the Bureau to plant certain species as fingerlings or yearlings at an age of from two to twelve months. This is found especially desirable with such species as the brook trout, but as some of the stations are not adapted for the rearing of trout, owing either to the extreme high temperature of the water in summer or to the presence of bacteria, in these cases the product is planted as fry. At stations where fingerlings and yearlings are reared, it is necessary to reduce the stock to prevent overcrowding as the fish become larger, and in such cases, so far as it is possible to do so, the precaution is taken to select for the earliest distribution waters where the fish will be least preyed upon by the larger fishes and other aquatic animals.

At the stations devoted to the propagation of black bass, much attention has been given to the subject of the age for distribution. From experience thus far, it appears very desirable to distribute the young fish when they are from 1 to 3½ inches in length, beginning the collections for this purpose soon after the young fish have broken up their schools and are scattered along the shores of the ponds. Bass five-eighths of an inch long will eat their young companions, one of this length having been found at the Fish Lakes station choked to death in its attempt to eat a younger fish of its own species. At the San Marcos, Tex., station it is customary to begin the distribution of black bass and other pond fishes in April, continuing throughout the summer.

The commercial species, such as the lake trout, white-fish, pike perch, cod, etc., which are hatched by the hundred million, are necessarily planted as fry, and it is customary to distribute them just before the umbilical sac is absorbed.

The work of distributing the fish collected along the overflowed lands of the Mississippi and Ohio rivers is entirely dependent upon high and low water conditions. During the past year the water was so high throughout the summer that the work of saving fish usually confined and doomed to perish in the lagoons caused by the receding waters was unnecessary. The fish distributed from these collections vary in size from fingerlings to 6 to 8 inches in length. All fish seined from these overflowed lands are either planted in adjacent waters or transported by car to other parts of the country to supply individual applicants for both public and private waters. Preparations were made during the past year for extending this field of operations by the establishment of an additional distributing station at North McGregor, Iowa, for collections in the lagoons along both sides of the Mississippi River from Dubuque, Ia., to La Crosse, Wis.

In the following tabulation all plants of fish and allotments of eggs are shown by species and waters stocked, the latter being grouped according to States, which are listed in alphabetical order.

Details of distribution.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Shad.			
Connecticut:			
State Retaining Pond, Joshuatown		3,000,000	
Pecks Pond, Strafford		2,770,000	
Delaware:			
Brandywine Creek, Wilmington		3,000,000	
St. Johns Creek, Dover		600,000	
Mispillian Creek, Milford		600,000	
Indian River, Millsboro		1,800,000	
District of Columbia:			
Potomac River, Three Sisters		162,000	
Georgia:			
Flint River, Albany		300,000	
Savannah River, Augusta		1,861,000	
Ocmulgee River, Macon		300,000	
Maryland:			
State Fish Commission, Baltimore	5,989,000	150,000	
Northeast River, Northeast	175,000		
Potomac River off Bryan Point		2,014,000	
Pamunkey Creek		3,655,000	
Piscataway Creek		1,064,000	
Swan Creek		1,963,000	
Broad Creek		1,122,000	
Susquehanna River, Port Deposit		400,000	
Havre de Grace		685,000	
Garrett Island		300,000	
Bush River, Bush River Station		533,000	
Patuxent River, Laurel		750,000	
Patapsco River, Relay		490,000	
Elk Creek, Elkton		533,000	
Chesapeake Bay off Havre de Grace		607,000	
Battery Haul		469,000	
Western Channel		1,148,000	
Massachusetts:			
Parker River, Bayfield		3,300,000	
Parkers Mill Pond, Wareham		295,000	
Assawompsett Pond, Middleboro		2,940,000	
Missouri:			
Louisiana Purchase Exposition, St. Louis	2,400,000		
New Jersey:			
Delaware River, Howells Cove		2,491,000	
Bennetts Fishery		2,063,000	
Gloucester	45,000		
South River, Old Bridge		450,000	
Rancocas Creek, Hartford		450,000	
New York:			
Hudson River, Catskill		3,000,000	
North Carolina:			
Trent River, Pollacksville		300,000	
Great Pedee River, Cordova		300,000	
Cape Fear River, Fayetteville		295,000	
Wilmington		440,000	
Newport River, Newport		390,000	
Lumber River, Lumberton		355,000	
Six Runs River, Clinton		300,000	
Scuppernong River, Columbia		450,000	
Pembroke Creek, Carters Landing		103,000	
Salmon Creek, Avoca		513,000	
Albemarle Sound, mouth of Salmon River	372,000	446,000	
Albemarle Sound, Capehart Fishery	4,188,000		
Albemarle Sound, Pembroke Creek		55,000	
Rhode Island:			
Tributaries of Narragansett Bay, Providence		2,950,000	
South Carolina:			
Catawba River, Catawba Station		240,000	
Pedee River, Pedee		445,000	
Edisto River, Jacksonboro		440,000	
Virginia:			
Chickahominy Creek, Walkers		490,000	
Meherrin River, Emporia		138,000	
Potomac River, Occoquan Bay		4,520,000	
Hunting Creek		3,546,000	
Pohick Creek		2,140,000	
Dove Creek		1,372,000	
Total	13,169,000	65,493,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Striped bass.			
Maryland:			
Chesapeake Bay, Western Channel		200,000	
North Carolina:			
Roanoke River, Weldon		3,698,000	
Total		3,898,000	
Quinnat salmon.			
Arkansas:			
Mammoth Springs, Mammoth Springs			750
California:			
State Fish Commission, Sisson	58,624,371		
Eel River	5,522,983		
McCloud River, Baird		2,350,130	
Maine:			
State Fish Commission, Winthrop	100,000		
Missouri:			
Little Piney River, Newburg			1,000
Local Streams, Rolla			1,000
Meramec Spring, St. James			1,000
McMahans Spring, Neosho			200
Louisiana Purchase Exposition, St. Louis			175
New Hampshire:			
State Fish Commission, Laconia	100,000		
New York:			
New York City Aquarium	1,000		
Oregon:			
State Fish Commission, Troutdale	7,506,000		
Yaquina Bay	3,063,000		
Clackamas River, Clackamas		572,070	
Spring Branch, Clackamas		5,675,177	
Tanner Creek, Bonneville		938,500	
Rogue River, Trail		9,023,428	
Washington:			
Olsen Creek, Underwood		1,208,200	
Columbia River, Underwood		4,742,600	
Little White Salmon Station		4,723,702	
Little White Salmon River, Little White Salmon Station		5,702,298	
Swift Creek, Whatcom County		35,000	
Baker Lake, Whatcom County		35,883	
New Zeland:	300,000		
New Zealand Government			
Total	75,217,354	35,006,988	4,125
Atlantic salmon.			
Maine:			
East Branch Mattawamkeag River, Oakfield			89,600
East Branch Penobscot River, Grindstone			194,300
Pleasant River, Brownville			85,100
East Branch Penobscot River, Hunt Farm		33,000	
Spencer Brook		24,000	
Little Spring Brook		1,845,716	
Spencer Rips		324,000	
Bowling Falls		105,000	
Devils Elbow		175,000	
Lunksoos		60,000	
New Hampshire:			
State Fish Commission, Laconia	20,000		
New York:			
New York City Aquarium, New York	2,000		
Applicant, New York	500		
Pennsylvania:			
State Fish Commission, Bellefonte	3,000		
Total	25,500	2,566,716	369,000
Landlocked salmon.			
California:			
State Fish Commission, Sisson	10,000		
Connecticut:			
State Fish Commission, Windsor Locks	10,000		
Maine:			
Webbs Pond, Franklin			3,000
Molasses Pond, Franklin			4,000
Fitz Pond, Holden			2,000
Great and Little Bear ponds, Canton			3,000
Phillips Lake, Dedham			3,500
Hurd Pond, Norcross			3,000
Varnum Pond, Farmington			8,000
Clear Water Pond, Farmington		4,000	4,000
Norcross Pond, Farmington			3,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Landlocked salmon—Continued.			
Maine—Continued.			
Arnold Pond, Farmington			2,400
Mirror Lake, Rockland			1,500
Camden Lake, Rockland			3,000
Alford Lake, Rockland			2,000
Tufts and Grindstone ponds, Kingfield			3,800
Sebago Lake, Mattocks			13,000
Long Pond, Great Pond			7,000
Pillsbury Pond, Newport			2,500
Quantabacook Pond, Belfast			2,800
Squaw Pan Lake, Presque Isle		5,000	5,000
South Pond, Warren			3,000
Crawford Lake, Warren			2,000
Unity Pond, Unity			3,000
Mount Blue Pond, Phillips			5,200
Nickerson Lake, Houlton			4,100
Woods Pond, Ellsworth			3,000
Pattens Pond, Ellsworth			4,000
Boydens Lake, Perry			2,000
Donnells Pond, Franklin			2,000
Rangeley Lakes, Oquossoc			10,022
Moose Pond, Hartland			1,700
Ohio Brook, Ayers Junction			3,000
Little Sebago Lake, White Rock			3,000
Sebago Lake, Sebago Lake			22,500
Green Lake, Great Brook			58,000
Little Rocky Pond, Dedham			2,000
Attean Lake, Jackman			3,000
Big Spencer Pond, Jackman			800
Notched Pond, New Gloucester			2,000
Lily Pond, Eastport			1,000
Cobbosseecontee Lake, Augusta			5,000
Messalonskee Lake, Oakland			1,000
Ellis and McGrath lakes, Oakland			1,200
Lake George, Skowhegan			2,000
Eastern Grand Lake, Danforth			3,000
Thomas Pond, Sebago Lake Station			2,000
Bog Lake, McGeorges Crossing			4,000
Hunters Lake, McGeorges Crossing			3,000
Flying Pond, Readfield			800
Green Lake, Otis			69,000
Branch Pond, Dedham			15,000
Lake St. George, Liberty			2,000
Moluncus Lake, Kingman			1,000
Portage Lake, Portage			19,000
Swan Lake, Searsport			1,000
Alligator Lake, Great Pond			1,000
Tunk Pond, Tunk Pond			1,000
Longs Pond, Bethel		5,000	
Woods Pond, Blue Hill		4,000	
State Fish Commission, Winthrop	25,000		
Massachusetts:			
Mashpee Great Lake, Sandwich			1,200
Neck Pond, West Barnstable			1,000
Lake Quinsigamond, Worcester			1,000
Fair Ground Lake, Worcester			100
Missouri:			
Louisiana Purchase Exposition, St. Louis			118
New Hampshire:			
Lake Massabesic, Manchester			3,500
Lake Winnepecket, Warner			1,500
Penacook Lake, Concord			1,500
Highland Lake, East Andover			1,500
Crystal Lake, West Canaan			2,500
Enfield			1,500
Lake Tarleton, Pike Station			1,800
Bow Lake, Rochester			1,000
Dan Hole Pond, Center Ossipee			1,500
Newfound Lake, Franklin			2,000
Webster Lake, Franklin			2,000
Lake Sunapee, Sunapee			4,500
Newbury			3,750
State Fish Commission, Laconia	10,000		
New York:			
Lake Madeline, Tupper Lake		9,200	
New York City aquarium	2,000		
Tuxedo Club, Tuxedo Park	5,000		
Applicant, Caledonia	10,000		
New York	500		

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Landlocked salmon—Continued.			
Oregon:			
Clackamas River			3,470
Vermont:			
Clyde River, Newport			4,488
Caspian Lake, Greensboro			7,000
Willoughby Lake, Westmore			7,000
Big and Little Averill lakes, Averill			4,700
Washington:			
Sullivan Lake, Newport			9,980
Argentina:			
Argentine Government	50,000		
Total	122,500	27,290	411,428
Silver salmon.			
Washington:			
Baker Lake, Whatcom County		2,234,645	
Silver Salmon Slough, Whatcom County		650,000	
Lower Baker River, Whatcom County		1,100,000	
Total		3,984,645	
Blueback salmon.			
Washington:			
Swift Creek, Whatcom County		1,730,000	
Baker Lake, Whatcom County		2,000,000	
Lower Baker River, Whatcom County		125,000	
Total		3,855,000	
Humpback salmon.			
Washington:			
Runths Spring Branch, Whatcom County		50,000	
Swift Creek, Whatcom County		35,397	
Baker Lake, Whatcom County		91,200	
Total		176,597	
Steelhead trout.			
Colorado:			
Musgrove Lake			8,000
State Fish Commission, Denver	40,000		
Idaho:			
Lake Coeur d'Alene, Coeur d'Alene			15,000
Iowa:			
Lake Okoboji, Spirit Lake			10,000
Maine:			
State Fish Commission, Monmouth	20,000		
Michigan:			
Big Blue Lake, Montague			24,000
Higgins Lake, Roscommon			25,000
Lake Superior, Tobins Harbor			10,800
Paint Creek, Ypsilanti		9,500	
State Fish Commission, Pontiac			15
Applicant, Negaunee	25,000		
Minnesota:			
Pike Creek, St. Louis County			20,000
Schultz Lake, St. Louis County			18,000
Missouri:			
Louisiana Purchase Exposition, St. Louis	26,000		250
Montana:			
Basin Creek, Harlowton			15,000
East Boulder Creek, Big Timber			10,000
Black-tail Lake, Butte			15,000
New Hampshire:			
State Fish Commission, Concord	20,000		
New York:			
Tuxedo Club, Tuxedo Park	10,000		
Oregon:			
Clear Creek, Stone		14,132	11,090
Rogue River, Rogue River Station		8,073	
City Reservoir, Astoria		1,000	
Vermont:			
Willoughby Lake, Westmore			13,000
Crystal Lake, Barton			16,900
Sleepers River, near St. Johnsbury			1,380
Caledonia Trout Club Pond, St. Johnsbury			5,000
Virginia:			
Reed Creek, near Wytheville			4,000
Elk Creek, Elkcreek			8,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Steelhead trout—Continued.			
Washington:			
Phinney and Grandy creeks, Skagit		70,000	
Argentina:			
Argentine Government	20,000		
Total	161,000	102,705	230,435
Loch Leven trout.			
Michigan:			
Intermediate Lake, Bellaire		118,000	
Big Sturgeon River, Indian River		20,000	
Fish Pond, Detroit			12
State Fish Commission, Pontiac			30
Missouri:			
Louisiana Purchase Exposition, St. Louis			91
South Dakota:			
Fish Pond, Roubaix		3,800	
Beaver Creek, Buffalo Gap		10,000	
Rapid Creek, Mystic		10,000	
Lower Iron Creek, Hermosa		10,000	
Spearfish Creek, Spearfish		7,500	2,158
Sunderland Pond, Spearfish		3,000	
Total		182,300	2,291
Rainbow trout.			
Alabama:			
Elberta Lake, Gadsden			400
Overlook Fish Pond, Trenton			400
Arizona:			
St. David Pond, Benson			500
Live Oak Creek, Flagstaff			1,000
Headwaters Oak Creek, Flagstaff			800
Oak Creek, Jerome			2,150
West Beaver Creek, Jerome			650
Clear Creek, Jerome			1,150
Sycamore Creek, Jerome			1,650
Cook Pond, Prescott			500
Arkansas:			
Spring Pond, Earnharts			300
Spring River, Imboden			400
Allens Mill Pond, Bentonville			300
Fish Pond, Bentonville			1,000
Flint Creek, Gentry			1,000
Spring Creek, Belleville			1,000
West Fork White River, Brentwood			800
Mammoth Springs, Mammoth Springs			1,250
Fish Pond, Belleville		10,000	
Fish Pond, Hatfield		10,000	
Spring River, Mammoth Springs		4,800	
Colorado:			
St. Vrain Reservoir, Lyons			800
North Fork Frying Pan River, Thomasville			1,500
Frying Pan River, Basalt			1,500
Upper Savage Lake, Thomasville			1,000
Lake Canal Reservoir, Windsor			1,500
Las Lagos, Blackhawk			800
Gunnison River, Gunnison			2,000
Lake Hassell, Idaho Springs			800
Clear Creek, Idaho Springs			1,500
Fall River, Idaho Springs			1,500
Roaring Fork River, Aspen			1,500
Big Thompson River, Loveland			2,000
Castle Creek, Aspen			2,000
Jefferson Lake, Jefferson			800
Gibson Creek, Webster			1,500
Platte River, Webster			4,000
North Fork South Platte River, Shawnee			2,000
South Fork Platte River			2,000
Platte River, Brookside			4,000
Grand River, Newcastle			2,000
Harrisburg Lake, Midland			500
Lake Otonowanda, Ridgway			800
Cottonwood Creek, Ridgway			1,500
North Crestone Creek, Creston			1,500
Clyde Pond, Clyde			500
Cimarron River, Cimarron			2,000
Beaver Creek, Clyde			500
Fish Pond, Glenwood Springs			16
Trout Ponds, Salida		5,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Connecticut:			
East Branch Silvermine Creek, Wilton			950
State Fish Commission, Windsor Locks	22,000		
Georgia:			
Kenesaw Springs, Kenesaw			400
Tibot Creek, Turnerville			800
Flat Creek, Turnerville			800
Fish Pond, Jasper			600
Mill Pond, Pinelog			1,600
Pinelog Creek, Pinelog			800
Tiger Creek, Ringgold			800
Chattahoochee River, Clarksville			1,000
Blacks Creek, Mathis			800
Fighting Town Creek, Pierceville			2,000
Walnut River, Belmont			500
Idaho:			
Crystal Lake, Hailey			2,000
Bear River, Soda Springs			2,500
Raymond Creek, Market Lake			3,000
Spring Creek, Pocatello			2,000
Clear Creek, Pocatello			2,000
Fish Pond, Pocatello			500
Camas Creek, Dubois			2,000
Port Neuf River, Pebble			500
South Fork Snake Creek, Lorenzo			1,500
Indiana:			
St. Marys Pond, South Bend			5,000
Farm Pond, Denver			3,000
Trout Pond, Crawfordsville		2,000	
Logansport		3,000	
Applicant, Bloomington	500		
Iowa:			
Yellow River, Waukon			2,500
Patterson Creek, Waukon			2,000
Roberts Creek, St. Olaf			2,500
Cox Creek, Strawberry Point			2,000
Sabula Park Pond, Sabula			1,000
Trout Creek, North McGregor			2,000
Bloody Run, North McGregor			2,000
Kramers Pond, Worthington			1,500
Fish Pond, Winterset			1,000
Haskell Springs, Fort Dodge			2,000
Silver Creek, Waukon			2,000
Williams Run, Waukon		15,000	
Otter Creek, Colmar			2,000
Canoe Creek and tributaries, Decorah			21,000
Wexford Creek, Harpers Ferry		15,000	
Maquoketa River, Forestville			4,500
Spring Branch, Manchester			400
Arnolds Spring Pond, Cresco		5,000	
Kansas:			
Soldier Creek, Topeka			1,000
Louisiana:			
Lake Marie, Natchitoches			239
Maine:			
Canaan Lake, Rockland			747
Maryland:			
Lake Ford, Oakland			500
Brownings Dam, Oakland			500
McHenry Lake, Oakland			500
Spring Lake, Oakland			400
McHenrys Lake, McHenry		6,150	
Star Bottle Creek, Belair			500
Cabbage Creek, Belair			800
Hollands Creek, Belair			500
Turkey Run, Rockridge			500
Bear Cabin Creek, Foresthill			500
Sink Hole Pond, Cumberland			300
Mine Branch, McIntire			1,500
Maryland:			
Rockvale Trout Run, Rocks			400
Springs Branch, Williamsport			500
Applicant, Baltimore	6,500		
Massachusetts:			
Whittier Pond, Whittiersville			500
Quinsigamond River, North Grafton			800
Fair Ground Lake, Worcester			24
State Fish Commission, Wilkinsonville	30,000		

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Michigan:			
Fish Pond, Farmington			3,000
Bass Lake, Iron Mountain			500
Flint and Clinton rivers, Oxford			4,400
Spring Pond, Spring Lake			5,400
McCutcheon Creek, Crystal Falls			2,500
Carleton Creek, Montague			4,400
Iron River, Iron Mountain			500
South Branch Au Sable River, Bay City		40,000	
Spring Brook Trout Company, Kalamazoo	20,000		
Minnesota:			
Lester River, Duluth		13,400	
State Fish Commission, St. Paul			34,800
Mississippi:			
Fish Lake, Corinth			800
Missouri:			
Mill Spring Lake, Humansville			1,850
Meramec River, Salem			500
Bennetts Mill Pond, Lebanon			3,000
Franks Lake, Dixon			2,750
Boiling Springs, Arlington			2,750
Little Piney River, Newburg		7,000	2,750
Meramec Spring, St. James			2,750
Blue Spring and Brazil creeks, Bourbon			5,750
Saltpetre and Spring creeks, Stanton			5,450
Indian Creek, St. Clair			2,750
Spring Pond, Goodman			4,025
Schlicht Spring, Schlicht Station			3,000
Swedeborg			2,750
McMahons Springs, Neosho			600
Lake Ha Ha Tonka, Ha Ha Tonka		5,000	
Louisiana Purchase Exposition, St. Louis	5,000		
Montana:			
Crow Creek, Townsend			2,500
Blacktail Deer Creek, Dillon			4,000
McIntosh Spring Creek, Red Rock			2,000
South Fork McDonald Creek, Lewistown			2,000
Big Deer Creek, Lewistown			2,000
Van Nest Pond, Lewistown			800
Whitmore Lake, Gold Butte			2,000
Knights Lake, Kalispell			1,500
Dempsy Creek, Deer Lodge			2,500
Nebraska:			
State Fish Commission, Long Pine Creek, South Bend	33,000		10,000
New Hampshire:			
Pond and streams, Potter place			6,485
Loon Lake, Plymouth			1,395
Mascoma River, Canaan			10,475
Isinglass River, Dover			1,600
Lake Wentworth, Hudson			600
New Jersey:			
Sindle Brook, Oakland			800
New Mexico:			
North Percha River, Nutt			1,000
Fish Pond, Dorsey			500
Spring River, Roswell			1,000
Bonita Pond, Capitan			300
New York:			
Indian Lake, Peekskill		10,000	900
New York City Aquarium	5,000		
Applicant, Brooklyn	1,000		
Applicant, New York	1,000		
North Carolina:			
Mill Pond, Louisburg			400
Fish Pond, Walnut Cove			400
Trout Lake, Lenoir			600
Bald Creek, Waynesville			1,000
Fish Pond, Saluda			1,050
Cockdills Creek, Waynesville			800
Barmans Creek, Loftis			750
Steels Creek, Loftis			750
Loftis Mill Creek, Loftis			750
Little River, Loftis			1,500
Pole Bridge Creek, Cedar Mountain			750
Buckhorn Creek, Cedar Mountain			750
Clear Creek, Cedar Mountain			750
Fish Pond, Brevard			500
Fish Ponds, Duketon			600
Little River, Grange			800
Fish Pond, Goldsboro			400

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
North Carolina—Continued.			
Thipps Pond, Greensboro			500
Campbell Branch, Maxton			400
Schaley Creek, Elk Park			2,000
Bull Creek, Swannanoa			800
Lake Woodlawn, Marion			400
Armstrong Creek, Marion			800
Ball Mountain Creek, Marion			800
Toms Creek, Marion			800
South Fork Swannanoa River, Black Mountain			800
Freeman Creek, Andrews			800
Trout Pond, Flat Rock			1,000
Spring Pond, Littleton			1,000
Nantahala River, Nantahala			1,600
Queens Creek, Nantahala			800
Franklin Lake, Brevard			2,700
Lake Toxaway, Brevard			3,900
North Toe River, Spruce Pine			1,000
Ohio:			
Cedar Creek, Springfield		5,000	
Fish Pond, Pomeroy		2,000	
Amanda		3,000	
Artificial Pond, Dennison		5,000	
Spring Lake, Sycamore			5,400
Oregon:			
Spring Branch, Dallas		3,000	
Rock Creek Lake, Haines		4,000	
Meadow Lake, Yamhill County			1,500
Trout Lake, Umatilla County			1,000
Clatskanie River, Clatsop County			500
Necanicum River, Clatsop County		9,000	4,500
Clear Creek, Stone		815	192
Meadow Lake, Carlton		6,000	
Fifteen Mile Creek, The Dalles		5,000	
Catherine Creek, Union		7,000	
Killimoque Creek, Haines		4,000	
Grande Ronde River, La Grande		8,000	
Spring Pond, Albany		3,000	
Beaver Creek, Albany		1,500	
Pennsylvania:			
House Creek, Pottsville			500
Woodard Pond, Columbia Cross Roads			400
Spring Run, Mercersburg			600
Moll Hollow Run, Mifflinburg			500
Limestone Run, Mifflinburg			500
Weiricks Gap Run, Mifflinburg			500
North Branch Buffalo Creek, Mifflinburg			500
South Fork North Branch, Mifflinburg			1,000
Raritan Run, Mifflinbuig			500
Panther Run, Mifflinburg			500
Toms Creek, Bushkill			600
Maple Run, Currys Station			350
Oriental Pond, Fairchance			300
Spring Meadow Brook, Bedford			500
Hermitage Pond, Euclid			300
East Dyberry Creek, Honesdale			500
Brinks Brook, Honesdale		4,970	
Sonners Pond, Honesdale		3,780	
Small Stream, Elkins			900
Sundrop Creek, Hamburg			500
Furnace Creek, Hamburg			500
Thomas Creek, Maria Furnace			500
Baigley Creek, Mansfield			500
Avery Pond, Honesdale			300
Rattling Run, Gordon			1,650
Buckhorn Creek, Gordon			500
Blair Furnace Pond, Altoona			300
O'Donnell Creek, Carbon Center			500
Mosquito Creek, Williamsport			700
Cove Creek, Bedford			1,000
Elk Run, Johnstown			500
Anderson Creek, Stewartstown			600
Bowmans Creek, Tunkhannock			500
Dark Hollow Creek, Tunkhannock			500
Wild Cat Run, Tamaqua			400
Leibys Run, Tamaqua			300
Upper Rabbit Run, Tamaqua			400
Busby Run, Tamaqua			400
Owl Creek, Tamaqua			300
Beaver Creek, Tamaqua			500

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Pennsylvania—Continued.			
Kreamers Run, Tamaqua			500
Falling Spring Creek, Chambersburg			600
Tributary of Fox Run, York			500
Dingman Run, Coudersport			600
Stream and lake, Jenkintown			900
Silver Creek, St. Marys			500
South Fork Powers Run, St. Marys			500
North Fork Creek, St. Marys			500
Kay Fork Creek, St. Marys			500
West Creek, St. Marys			500
Byrnes Creek, St. Marys			500
Black Creek, Tremont			500
Coleri Creek, Tremont			500
Cabin Branch, Hellam			500
Rattling Run, Minersville			600
Wheeler Run, Minersville			650
West Falls Creek, Minersville			600
Deep Creek, Minersville			650
Spring Creek, Mahanoy City			500
Nigger Hollow Creek, Mahanoy City			500
Messer Run, Mahanoy City			500
Broad Mountain Creek, Mahanoy City			400
Locust Creek, Mahanoy City			500
Mill Stony Creek, Mahanoy City			500
Codoras Creek, Mahanoy City			500
Krells Pond, Mahanoy City			300
Little Need Creek, Mahanoy City			500
Still Creek, Mahanoy City			500
Brush Valley Creek, Ashland			500
Roaring Creek, Ashland			500
Buckhorn Creek, Ashland			500
Clarks Creek, Tower City			500
Creek and pond, Tower City			300
Davis Run, Shenandoah			600
Waste House Run, Shenandoah			500
Laurel Creek, Williamsport			700
Fishing Creek, Jamison City			600
Goldmine Creek, Goldmine			500
Wolf Creek, Pottsville			400
Werden Creek, Hudson			500
Shaffers Creek, Hudson			500
Pigeon Creek, Jamison City			600
Panther Creek, Jamison City			600
Aqua Nueva Lake, Rosedale			300
McMichaels Creek, Stroudsburg			1,500
East Branch Run, Henryville			1,500
Buckhill Creek, Cresco			1,500
Paradise Creek, Mount Pocono			1,500
Five Mile Creek, Lake Ariel		5,000	
Spring Creek, Wayne County		4,380	
Susquehanna River, Wilkesbarre		13,300	
State Fish Commission, Bellefonte			1,000
South Dakota:			
Tributary of Whitstone Creek, Bonesteel			1,000
Fish Pond, Eureka			300
Spring Run Pond, Galena			1,200
Rapid Creek, Rapid City			2,500
Deer Creek, Rapid City			1,250
Beaver Creek, Buffalo Gap			3,000
Cascade Creek, Cascade Springs			1,000
Red Earth Creek, Hermosa		1,000	
Sturgis Park Lake, Sturgis		1,000	
Tennessee:			
Fish Pond, Kenton			900
Drakes Creek, Avondale			700
Greenwood Lake, Sherman Heights			400
Fish Pond, Arthur			600
Doe River, Hampton			1,200
Little Doe River, Hampton			1,200
Mill Pond, Dunn			450
London			800
Roan Creek, Blevins			1,200
Tiger Creek, Blevins			1,200
Big Creek, Newport			2,000
Teg Creek, Gang			1,200
Ledford Pond, Tullahoma			200
Spring Branch, Erwin			1,415
Burts Branch, Crandell			1,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
Tennessee—Continued.			
Tagell Branch, Crandell			1,000
Parks Branch, Crandell			1,500
Beaver Dam Creek, Crandell			4,960
Cove Creek, Buckeye			1,200
Cane Creek, Kimmins			900
Fish Pond, Fayetteville			300
Duck River, Columbia			400
Utah:			
Applicant, Salt Lake City	25,000		
Vermont:			
Black Pond, Woodstock			16,000
Virginia:			
Great Run, Fauquier Springs			500
Fish Pond, Beaverdam			500
Capon Roads			300
Jeremiah Run, Rileyville			500
Gooney Creek, Front Royal			1,000
Little North River, Harrisonburg			1,000
Highland Terrace Lake, Harrisonburg			300
Dry River, Harrisonburg			800
Bellevue Ice Pond, Bellevue			400
Darns Creek, Winchester			500
Vancluse Lake, Winchester			300
Snake Den Creek, Hunters			4,400
North Creek, Indian Rock			2,000
Little Burnley Creek, Abingdon			500
Mill Creek, Chilhowie			500
Fish Pond, Broadnax			300
" Lynchburg			300
Rabbit Creek Pond, Fosters Falls			500
Crystal Pond, Crimora		2,000	
Difficult Run, Vienna			1,150
Nick Creek, Atkins			1,000
Bradley Branch, Bradley			2,000
Laurel Creek, Damascus			1,000
Maple Branch, Damascus			1,000
Laurel Run, Timberridge		19,800	
Fish Pond, Afton		1,600	
Spring Pond, Luray		5,000	
Dry River, Elkton		4,000	
Bluestone River, Graham		8,000	
Cedar Creek, Natural Bridge		9,000	
Long Gentry Creek, Gala		5,000	
Bassett Creek, Bassett		2,500	
Mountain Stream, Luray		5,000	
Happy Creek, Front Royal		1,500	
Elk Creek, Shenandoah Junction		4,500	
Town Creek, Abingdon		7,500	
Belfer Pond, Abingdon		2,500	
Mile Run, Island Ford		4,000	
Blackberry Creek, Bassett		1,500	
Leatherwood Creek, Dyer Store		1,500	
Peach Bottom Creek, Longs Gap		5,000	
Beaver Creek, Martinsville		1,500	
Jones Creek, Martinsville		1,500	
Fish Pond, Martinsville		2,000	
Washington:			
Wagner Lake, Wilbur			1,500
Cowiche Creek, North Yakima			2,000
Hidden Lake, North Yakima			1,500
Troublesome Creek, Madison		5,000	
Cold Spring, Creston		8,000	
West Virginia:			
Rich Creek, Petersontown			800
Edgewood Spring, Bunker Hill			500
Fish Pond, Monongah			300
Trout Run, Romney			500
Fish Pond, Brookside			300
Shade and Ephraim Creeks, Beury			5,000
Horseshoe Pond, Eglon			300
Penny Run Pond, Eglon			300
Fish Pond, Marlinton			1,000
Gauley River, Camden on Gauley			800
Branches of Greenbrier River, Durbin			5,000
Leetown Run, Shenandoah Junction			400
Sweet Springs Creek, Sweet Springs			500
Cove Creek, Sweet Springs			500
Big Clear Creek, Alderson			1,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Rainbow trout—Continued.			
West Virginia—Continued.			
Mouth Cherry River, Curtin			1,000
Cranberry River, Cranberry			2,450
Gauley River, Richwood			1,800
Enochs Creek, Enoch Siding			800
Spring Creek, Falling Springs			1,000
Spring Branch, White Sulphur Springs			1,480
Howards Creek, White Sulphur Springs			1,500
Mill Creek, Macdonald		21,383	
Williams River, Marlinton		21,000	
Laurel Creek, Marlinton		25,000	
Locust Creek, Beard		20,000	
Spring Branch, Scott		5,000	
Wisconsin:			
Pigeon Creek, Alma Center		15,000	
Tributary of Main Creek, Ingram		5,000	
Wausaukee River, Athelstane			4,080
South Branch, Pike River			4,080
Medicine Brook, Pike River			4,080
Middle Inlet, Pike River			4,080
South Inlet, Pike River			4,080
Wyoming:			
State Fish Commission, Wolf	25,000		
England:			
Applicant, Malvern Wells	10,000		
Canada:			
Applicant, Owen Sound	20,000		
France:			
Applicant, Lyons	10,000		
Total	214,000	471,378	523,103
Black-spotted trout.			
Colorado:			
Rhyolite Reservoir, Gillett			15,000
Baker Lake, Jefferson			20,000
Fall Creek, Colorado Springs			30,000
Chicago Lake, Idaho Springs			15,000
Chinns Lake, Idaho Springs			15,000
Cascade Creek, Cascade			35,000
Lime Creek, Thomasville			35,000
Big and Little Cimarron Rivers, Cimarron			50,000
Millers Lake, Idaho Springs			15,000
Snow Mass Creek, Snow Mass			30,000
Maroon Creek, Aspen			30,000
Big Thompson River, Loveland			65,000
Upper Pienas Creek, Del Norte			35,000
Platte River, Cliff			30,000
Buffalo			30,000
Shawnee			30,000
South Platte River, Dome Rock			30,000
North Platte River, Shawnee			40,000
South Fork Platte River, South Platte			30,000
North Fork South Platte River, Estabrook			50,000
South Platte River, Muldoon			30,000
South Fork St. Vrain River, Lyons			40,000
St. Vrain River, Lyons			40,000
Rock Creek, Dillon			40,000
Eagle River, Berrys Station			90,000
Lake Eldora, Eldora			30,000
Tennessee Creek, near Leadville			40,000
Cache La Poudre River, Fort Collins			145,000
Lawn Lake, Loveland			20,000
Lake Wauconda, Perry Park			25,000
Taylor Creek, West Cliff			50,000
Clear Creek, Granite			35,000
Sylvan Lake, Placerville			15,000
Naylor Lake, Georgetown			25,000
Buffalo Creek, Estabrook			30,000
Fern Lake, Morain			15,000
Odessa Lake, Morain			15,000
Grand Lake, Grand Lake			153,800
Alexander Lake, Delta			128,500
North Fork Gunnison River, Delta			75,000
Hotchkiss			75,000
Pavonia			50,000
Harbison Lake, Grand Lake			5,300
North Fork Grand River, Grand Lake			25,000
Grand River, Grand Lake			25,000
Island Lake, Cedaredge			260,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Black-spotted trout—Continued.			
Colorado—Continued.			
Barren Lake, Cedaredge			130,000
Willow Creek, Dexter			5,000
South Fork Grand River, Lehman			25,000
Strawberry Lake, Lehman			5,000
Frazier River, Coulter			25,000
Frying Pan River, Ruedi			100,000
Platte River, between Grant and South Platte			100,000
Boulder Creek, Dillon			30,000
Dallas and Dolores rivers, Ridgway			75,000
East Beaver, Middle, and Bison creeks, near Cripple Creek			75,000
South Fork White River, Meeker			25,000
Deep and Grizzley creeks, Glenwood Springs			50,000
Rio Grande River, between Del Norte and Creede			100,000
Grand River and tributaries, Newcastle			50,000
Crystal River, Redstone			100,000
Trout Ponds, Granite			10,000
North and South Fork St. Vrain River, Lyons			100,000
Eggleston Lake, Cedaredge			130,000
Island Lake and streams, Cedaredge			135,000
Ward Lake, Cedaredge			135,000
Headwaters Frazier River, Empire			75,000
Lake Creek, Leadville			50,000
Idaho:			
Mattson Pond, Vollmer			13,000
Anderson Lake, Market Lake			3,000
Witter Lake, Priest River			3,000
Spring Creek, Soda Springs			5,000
Beaver Canyon Creek, Humphrey			8,000
Port Neuf River, Pebble			45,000
Iowa:			
Spring Branch, Manchester			10,000
Spring Branch, Forestville			8,000
Missouri:			
Louisiana Purchase Exposition, St. Louis	44,000		34
Montana:			
Prescotts Reservoir, Hill			15,000
Bull Run Pond, Butte			5,000
Lake McDonald, Belton			12,000
Sixteen Mile Creek, Sixteen			10,000
Tributaries of Sixteen Mile Creek, Bakers			19,000
South Fork of Sixteen Mile Creek, Bakers			8,000
Tributary of Sixteen Mile Creek, Canyon			7,000
Musselshell River, Two Dot			7,000
Jocko Creek, Arlee			15,000
Crow Creek, Arlee			15,000
Mission Creek, Arlee			15,000
Belt Creek, Monarch			15,000
Black Tail Deer Creek, Dillon			15,000
Jake Canon Creek, Dillon			15,000
Cotton Wood Creek, Dillon			10,000
Alkali Creek, Dillon			15,000
North Fork of Milk River, Chinook			30,000
Fish Lake, Hayden			5,000
Arnells Creek, Lewistown			7,000
Decker Creek, Red Rock			8,000
Warm Spring Creek, Logan			10,000
Lake Morrison, Dell			10,000
Lake Kiote, Dell			3,000
Cotton Wood Lake, Dell			5,000
Deadman Lake, Dell			5,000
Coburn Reservoir, Malta			10,000
Lost Camp Creek, Harlowton			12,000
Tillinghast Creek, Monarch			12,000
Cow Creek, Harlem			15,000
Trout Pond, Bozeman			3,000
Horse-Shoe Lake, Twin Bridges			8,000
Pritchard Lake, Gold Butte			3,000
Smith River, White Sulphur Springs			7,000
Checker Board Creek, White Sulphur Springs			5,000
Bison Creek, Basin			15,000
Muskrat Creek, Boulder			15,000
Spring Branch, Livingston			10,000
South Boulder Lake, Jefferson Island			5,000
Dog Lake, Plains			10,000
Avoca Creek, Monarch			15,000
East Buffalo Creek, Ubet			7,000
Indian Creek, Minden			10,000
Boyd Creek, Lewistown			5,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Black-spotted trout—Continued.			
New Mexico:			
Carrizo Creek, Clayton			70,000
Cieneguilla del Burro Creek, Clayton			70,000
Alamora Creek, Clayton			20,000
Alamosita Creek, Clayton			20,000
Oregon:			
Fish Pond, Junction City			5,000
Trout Lake, Umatilla County			14,000
Clear Creek, Stone			2,010
Necanicum Creek, Astoria		10,620	
Rogue River, Rogue River		8,695	
South Dakota:			
Fish Lake, Bonesteel			10,000
Battle River, Hermosa			35,000
East Fork of Spearfish Creek, Englewood			25,000
Spearfish Creek, Elmore			10,000
Whitewood Creek, Englewood			50,000
North Fork of Little Rapid Creek, Dumont			35,000
Spring Creek, Rapid City			35,000
Rapid Creek, Rapid City			100,000
Box Elder Creek, Rapid City			35,000
Iron Creek, Hill City			30,000
Spring Creek, Hill City			65,000
False Bottom Creek, St. Onge			25,000
Beaver Creek Pond, Spearfish			25,000
Spearfish Creek, Spearfish			625,000
Cow Creek, Spearfish			25,000
Water Cress Creek, Spearfish			25,000
Franklin Creek, Spearfish			25,000
Cox Creek, Spearfish			25,000
Spring Creek, Spearfish			25,000
Montana Lake, northwest of Spearfish			10,000
Castle Creek, Mystic			85,000
Spearfish Creek, Elmore			95,000
Sylvan Lake, Custer			50,000
Squaw Creek, Maurice			25,000
Silver Creek, Sturgis			25,000
Bear Butte Creek, Sturgis			25,000
Little Rapid Creek, Rochford			50,000
North Castle Creek, Rochford			25,000
Lime Creek, Rapid City			25,000
Trout Ponds, Piedmont			25,000
Elk Creek, Piedmont			10,000
Little Elk Creek, Piedmont			25,000
Beaver Creek, Buffalo Gap			55,000
Evans Lake, Hot Spring			27,000
Cold Brook, Hot Spring			18,000
Utah:			
Tributaries of Provo River, Heber			100,000
Washington:			
Branch Clover Creek, Lake View			14,995
Speller Creek, Northport			5,000
Muskrat Lake, Curlew			8,000
Yakima River, Clealum			10,000
Wyoming:			
Trail Creek Pond, Sundance			10,000
Duck Lake, Yellowstone National Park			290,000
Yellow Stone Lake, Yellowstone National Park			22,000
State Fish Commission, Laramie	200,000		
Ranchester	200,000		
Wales:			
Applicant, Upper Downing, North Wales	25,000		
Total	469,000	19,315	6,646,139
Brook trout.			
California:			
State Fish Commission	200,000		
Colorado:			
Cole Creek Pond, Telluride		5,000	1,000
Lake Wauconda, Perry Park			3,000
Platte River, Shawnee			3,500
Middle Elk Creek, Newcastle			3,000
Fish Pond, Carbondale			2,000
Colorado Springs			800
Wrights Lake, Colorado Springs			800
Little Cimarron River, Montrose			3,000
Jarvis Creek, Montrose			2,000
Fish Pond, Basalt			800
Fork of San Juan Creek, Pagosa Springs		10,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Colorado—Continued.			
Naylor Lake, Georgetown			5,000
Elk Creek, Newcastle			3,000
Davis Lake, Telluride			1,000
Lake Alicia, Thomasville			2,500
Youngs Lake, Leadville			150,000
Nueva Lake, Summit County			60,000
Private Lake, Jefferson			45,000
Spring Brook, near Leadville			1,500
Rocky Lake, Fort Collins			25,000
Trout Pond, Glenwood Spring			20
Fall Creek, Fairview		10,000	
Big Thompson River, Loveland		15,000	
Roaring Fork River, Loveland		5,000	
Boulder Creek, Dillon		5,000	
Boulder Lake, Dillon		5,000	
Nathrop		5,000	
Straight Creek, Dillon		5,000	
Trout Lake, Buena Vista		5,000	
Lake Eldora, Boulder		15,200	
Baumbicker Fish Pond, Granite		5,000	
Beaver Flat Lakes, Webster		8,000	
Ute Park Lake, Ute Park		5,000	
Spring Creek, Montrose		5,000	
Lower Spring Creek, Montrose		5,000	
Rock Creek, Montevista			10,000
Basin Lake, Carbondale			5,000
Lake William Dale, Carbondale			5,000
St. Vrain Creek, Lyons			75,000
Lake Lenore, Ouray			8,000
Stapps Lake, Ward			5,000
Upper Crystal River, Redstone			10,000
Snake Creek, Grant			8,000
South Platte River, Florissant			10,000
Trout Ponds, Derry's Ranch			114,000
Los Pinos Creek, Osier			25,000
Musgrove Lake, Musgrove			366,000
South Platte River, Cassells			10,000
Alturia			5,000
Maddox			10,000
Brookside			10,000
Glenisle			15,000
Vasquez Creek, Empire			25,000
East Beaver Creek, Rosemont			10,000
Gould Creek, Saderlind			10,000
Basin Creek, Clyde			5,000
Eagle River, Berrys Station			15,000
Grizzly Creek, Glenwood Springs			15,000
Lake Alicia, North Fork			89,800
Fryingpan River, Ivanhoe			5,000
Mast			10,000
North Fork			10,000
Lime Creek			10,000
Ruedi			15,000
Dallas Creek, Ridgway			25,000
Connecticut:			
Coscob Brook, Coscob			15,000
Ponds and stream, Bolton			875
Neck River, Winsted			1,000
Ryan Brook, Winsted		7,000	
Spring Brook, Middletown		10,000	
Mad River, Waterbury		10,000	
Georgia:			
Hickory Creek, Murray County			2,000
Idaho:			
Glenrea Lakes, Rea			2,000
Fish Ponds, Pick			1,500
Toohy Lake, Soda Springs			800
Big Bear Creek, Kendrick			2,500
Trout Pond, Kendrick			800
Soda Springs			800
Witter Lake, Priest River			500
Montpelier Creek, Montpelier			2,500
Fish Pond, Vallmer			800
Spring Lake, Rathdrum			2,000
Port Neuf River, Pebble			2,500
Clearwater River, Lewiston			1,500
Applicant, Spencer	25,000		
Illinois:			
McNetts Creek, Cary Station		3,500	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Indiana:			
Perleys Pond, South Bend		5,000	
Waterview Pond, Crawfordsville			1,000
Iowa:			
Baldwins Brook, Cresco		8,000	
Maine:			
Billings Pond, Blue Hill		15,000	3,000
Thurstons Brook, Sedgwick			4,000
Perkins Brook, North Berwick			3,000
Salmon Lake, Rangeley			3,000
Marsh River, Brooks			3,000
Round Pond, Norway			1,000
Rangeley Lakes, Oquossoc			10,300
Sprague Pond and Brook, Waldoboro			2,000
Carry Pond, Bingham			2,000
Fish Pond, Farmington			1,000
Canaan Lake, Rockland		30,000	1,000
Flying Pond, Redfield			1,000
Nessalonskee Lake, Oakland			800
McGraw Pond, Oakland			800
Ellis Pond, Oakland			800
Carp Pond, East Orland			10,000
Craig Pond, East Orland		30,000	4,000
Swan Lake, Searsport			500
Mill Brook, Cumberland Junction			1,200
North Twin Lake, Norcross			3,000
Little Houston Pond, Katahdin Iron Works			900
China Lake, Waterville			1,200
Sebago Lake tributaries, Mattocks			12,800
Spring Lake, Bigelow		30,000	
Clearwater Lake, Farmington		40,000	
Shephards River, Brownfield		155,000	
Pillsbury Pond, Newport		30,000	
Rowe Pond, Cumberland Junction		10,000	
Bingham		25,000	
Willett Meadow Brook, Waldoboro		40,000	
Squaw Pan Lake, Presque Isle		40,000	
Eagle Lake, Mount Desert		40,000	
Sandy Brook, Unity		30,000	
Spring River Lake, Franklin		30,000	
St. Georges River, Belfast		40,000	
Longs Pond, Bethel		40,000	
Lake Cobosseecontee, Augusta		50,000	
Stiles Brook, Brooks		25,000	
Sebago Lake, Sebago Lake		150,030	
Johnsons Trout Brook, Burnham Junction		25,000	
Pattens Pond, Ellsworth		25,000	
Holbrooks Pond, Dedham		10,000	
Branch Pond, Dedham		30,000	
Phillips Lake, Dedham		10,000	
Green Lake, Dedham		170,000	
Otis		130,000	
Maryland:			
Reservoir, Mountain Park			500
Spring Branch, Williamsport			800
Spring Lake, Oakland			500
Marsh Run, Oakland			500
Brownings Dam, Oakland			1,500
Little Seneca Creek, Germantown			500
Tributary of Gunpowder River, Glencoe			500
Spring Branch, Cockeysville			500
Patapsco Creek, Woodbine			1,500
Patuxent River, Woodbine			2,000
Mill Creek Dam, Perryville			3,000
McHenry Lake, McHenry		18,000	
Trout Pond, Deer Park		18,000	
Massachusetts:			
North Branch, Springfield			1,000
Parsons Brook, Northampton			875
Fairbanks Brook, North Grafton			375
Burnitt Brook, North Grafton			375
Merriam Brook, North Grafton			250
Stillwater River, Sterling Junction			875
Babcock Brook, Princeton			850
Trout Brook, Jamesville			500
Sewell Brook, Worcester			1,000
Fair Ground Lake, Worcester			24
Lake Quinsigamond, Worcester			2,000
Pleasant View Lake, Williamsburg			400
Felton Brook, Clinton		10,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Massachusetts—Continued.			
Cold Spring Brook, Saundersville		5,000	
Carroll Brook, Saundersville		5,000	
Crosby Brook, Saundersville		5,000	
Stow Brook, Worcester		10,000	
Mill Pond, Gloucester		5,000	
Jemisons Brook, Millburg		5,000	
Michigan:			
Turk Lake Creek, Greenville		10,000	
Stoney Creek, Shelbyville		20,000	
West Branch of Succor Creek, Mayville		10,000	
Hamilton Creek, Mayville		10,000	
Phelps Creek, Mayville		10,000	
Inlet to Phelps Lake, Mayville		10,000	
Herbe Creek, Mayville		15,000	
Tompkins Creek, Mayville		15,000	
Sycamore Creek, Lansing		25,000	
Spring Brook, Novi		10,000	
Minnehaha River, Oden		15,000	
Spring Creek, Iron Mountain		4,000	
Benson Creek, Mount Morris		15,000	
Spring Brook, Milford		15,000	
Trout Pond, New Buffalo		10,000	
Spring Creek, Alpena		15,000	
Tributary of Turtle Creek, Alpena		50,000	
Bigton Creek, Newaygo		30,000	
Safe Harbor Creek, Carsonville		25,000	
Happy Hollow Fish Ponds, Hillsdale		30,000	
Smith and Hale Creeks, Emery Junction		25,000	
Gold and Silver Creeks, East Tawas		50,000	
Van Wetten Creek, Mikado		25,000	
Pine River and creeks, Lincoln		25,000	
Rapid River, Leetsville		20,000	
Maple River, Pellston		50,000	
Carp River, Carp Lake		20,000	
Johnson Creek, Prescott		25,000	
Hall Creek, Farwell		10,000	
Newton Creek, Farwell		10,000	
Spring Brooks, Clair		20,000	
Dennis Creek, Lake		10,000	
Trout Brooks, Baldwin		15,000	
Bowen and Cedar Creeks, Wingleton		15,000	
Trout Brook, Branch		10,000	
Beitners, Anderson, and Fletcher Creeks, Grawn		10,000	
Beitners Creek, Traverse City		10,000	
Boardman River, Traverse City		10,000	
Desmond Creek, Barker Creek		10,000	
Mason Creek, Barker		5,000	
Barker Creek, Barker		5,000	
Orr Creek, Ellsworth		8,000	
Wood Creek, Ellsworth		8,000	
Bass Creek, Ellsworth		4,000	
Beaver Creek, Kalega		5,000	
Cedar Creek, Kalega		5,000	
Trout Brooks, Bellaire		20,000	
Fish Pond, Shepardville			7,500
Gaylords Pond, Williamston			7,500
Minnesota:			
Cooks Valley Brook, Wabasha			250
Lake La Valle, Lamoille			300
Clear Creek, Nickerson			250
Poplar River, Lutsen		5,000	
Sucker Brook, Detroit		5,000	
Rocky Run, Carson		6,000	
Talmadge Creek, St. Louis County		5,000	
Moose Creek, Duluth		5,000	
Missouri:			
Louisiana Purchase Exposition, St. Louis			71
Montana:			
Spring Creek, Lewistown			500
East Fork of Spring Creek, Lewistown			3,500
Beaver Creek, Lewistown			3,500
Boyd Creek, Lewistown			3,500
Browns Gulch Creek, Butte			4,500
Ashly Lake, Kalispell			2,000
Little Sheep Creek, Lima			3,000
Fish Pond, Anaconda			500
Elk Lake, Arlee			2,000
Rose Lake, Red Rock			800
Trout Pond, Bozeman			1,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Montana—Continued.			
Fish Pond, Gold Butte			1,200
McDonald Creek Lake, Gold Butte			800
Fish Pond, Goodman Siding			500
Rock Creek, Brownes			2,500
Crystal Lake, Sheridan			3,000
Belt Creek, Neihart			3,000
Trout Pond, Laurel			800
American Creek, Harlowton			3,000
East Boulder Creek, Big Timber			5,600
Carmichael Creek, Craig			1,200
Fish Pond, Victor			500
Bozeman			2,000
Reservoir, Hill			800
Little Boulder Creek, Boulder			3,000
North Fork of Sun River, Craig			2,000
Highwood Creek, Fort Benton			800
Nebraska:			
State Fish Commission, Bordeaux Creek, Southbend			800
Niobrara River, Cody		5,000	
State Fish Commission, Southbend	50,000		
New Hampshire:			
Dudleys Brook, Exeter			1,000
Wild Meadow Brook and Pond, Grafton		29,800	5,000
Lake Winnepecket, Warner			1,000
Cole Pond and Brook, Potter Place		8,000	2,800
Moscoma River, Canaan			2,500
Roaring Brook, Winchester			1,994
Mirey Brook, Winchester			997
Head Suncook River, Concord			800
Ceasar Brook, Milford			1,000
Silica Bed Brooks, Troy			1,000
Rum Brook, Epping			1,000
Merrie Mio Creek, Sunapee			1,000
Tannery Brook, Manchester		5,000	5,000
Watts and Little Cohass brooks, Manchester			1,000
Peters and Millstone brooks, Manchester			1,000
Harry Brook, Manchester			1,000
James Brook, Manchester		5,000	1,000
Dearborn Brook, Manchester		5,000	1,000
Boyce Brook, Manchester		8,000	1,000
Little Brook, Manchester			1,000
Townsend Brook, Wolfboro			1,000
Little River, Lee			1,000
Dalton Brook, Manchester		8,000	1,000
Peters Brook, Manchester			1,000
Reservoir, Manchester			500
Peters Spring, Manchester			500
Robie Run Brook, Manchester			1,000
Warren Brook, Manchester			1,000
Damons Brook, Manchester		5,000	1,000
Bowmans Brook, Manchester		5,000	1,000
Shingle Brook, Manchester			1,000
Manter Brook, Manchester		8,000	
Stump Meadow Brook, Manchester		5,000	
James and Peters brooks, Manchester		5,000	
Shepard Brook, Manchester		5,000	
Ray Brook, Manchester		5,000	
Dogmond Brook, Manchester		5,000	
Medlin Brook, Manchester		5,000	
Farm Brook, Manchester		10,000	
Dumpling Brook, Manchester		5,000	
Christian Brook, Manchester		5,000	
Walkers Brook, Manchester		5,000	
Tannery Brook, Concord			1,000
Dolph Brook, Concord			1,000
Bowboy Brook, Concord			1,000
Clough Brook, Concord			1,000
Eastman Brook, Concord			1,000
Ash Brook, Concord			1,000
Trout Pond, Concord			800
Little River, North Hampton		5,000	1,000
Blodgett Ponds, Wentworth			500
West Branch, Bradford			1,000
California Brook, West Swanzy			997
Shaker Brook, Marlboro			1,000
Blood Brook, West Lebanon			1,000
Tributaries of Souhegan River, Greenwich			1,000
Sandwich Pond, Plymouth		8,000	800
Flowage Brook, Hookset			1,000

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
New Hampshire—Continued.			
Tucker Brook, Milford			1,000
Quoquinine Creek, Milford			1,000
Osgood Brook, Milford			1,000
Witch Brook, Milford			1,000
Fish Pond, West Springfield			1,000
Grafton County			800
Loon Lake, Plymouth			800
Emerson Creek, Petersboro			1,000
Slide Brook, Scotts			1,000
Nash Brook, Groveton			1,000
Chase Brook, Nashua			1,000
Trout Pond, Whitefield		10,000	
Rowell Pond, Franklin			500
West Branch, Campton Village			1,000
Brown Brook, Ashland			1,000
Dan Hole Pond, Center Ossipee			995
Flinta Creek, Hollis			1,000
Mad River, Campton Village			1,000
Johnsons brooks, Pike Station			998
Alvirne Pond, Nashua		8,000	
Putney Creek, North Weare		8,000	
Lake Sunapee, Newberry			2,495
Birch Brook, Newberry			2,495
Claybank Brook, West Ossipee			1,000
Elmwood Brook, Elmwood			1,000
Ayers Brook, Hudson			1,500
Mountain Lake, Sanbornville			2,464
Gile Ice Pond, Franklin		4,000	
Ponds and brook, Whitefield		10,000	
Laurel Lake, Fitzwilliam		10,000	
Ammonoosuck River, Fabyans			10,000
Trout Pond No. 2, Potter Place		10,000	
Rand Brook, Greenfield		5,000	
Silver Brook, Warner		8,000	
Long Pond, Warner		8,000	
Tilton Brook, East Andover		8,000	
Stevens Brook, Warner		8,000	
Fish Pond, Keene		4,000	
Cole, Onestack, Gage, and Virgin brooks, Concord		12,000	
Boat Meadow Brook, Hookset		8,000	
Ragged Mountain Brook, Potter Place		5,000	
Spring Brook, Nashua		5,000	
Baldwin Brook, Milford		10,000	
New Jersey:			
Bushes Pond, Morris County			400
Rockaway River, Dover			400
Applicant at Branchville	20,000		
New Mexico:			
Byler Spring, Clayton			800
Miller Lake, Clayton			800
Travajos Spring, Clayton			1,500
Apache Spring, Clayton			800
Chama Creek, Chama		25,000	
New York:			
Carleton ponds Carleton Island		100,000	
Owego Creek, Owego		20,000	
Gollands Pond, Syracuse		10,000	
Loon Lake, Malone		45,000	
Lake Titus, Malone		10,000	
Little River, Benson Mines		100,000	
Wist Creek, Watertown		50,000	
Stockwell and Evans creeks, Watertown		40,000	
Powell and Clarke brooks, Stittville		50,000	
Woodward Pond, Adams Center		10,000	
Hubbard Creek, Carthage		50,000	
Independence Creek, Adirondack Station		10,000	
Pleasant and Chase lakes, Pleasant Lake		85,000	
Marshall Brook, Adirondack Station		10,000	
West Brook, Adirondack Station		10,000	
West Canada Brook, Adirondack Station		20,000	
Hazel and Taylor brooks, Adams		13,000	
Beaver River, Beaver River		50,000	
State Fish Commission, Pleasant Valley Hatchery		103,600	
Caledonia Hatchery		97,000	
New York City Aquarium	5,000		
Applicant, New York	6,000		
Spring Pond, Herkimer		15,000	
West Mill and Sandy creeks, Watertown		100,000	
Stoney Brook, St. Regis Falls		25,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
New York—Continued.			
Woods Lake, Northville		35,000	
West Canada Creek, Waterville		30,000	
Schlalons Creek, East Worcester		35,000	
Green Lake, Syracuse		25,000	
Preston Ponds, North Creek			875
Miramitchee Creek, Poughkeepsie			500
Virgil Creek, Dryden			1,000
East Brook, Eastport			1,000
North Carolina:			
West Buffalo Creek, Andrews			500
Big Snowbird Creek, Andrews			500
Little Snowbird Creek, Andrews			500
Santeetla Creek, Andrews			500
Sycamore Creek, Morrisville			875
Shipfords Creek, Davidsons River			900
Pigeon Roost Creek, Mitchell County			10,000
Hollow Poplar Creek, Poplar			2,900
North Dakota:			
Spring Lake, Rugby		6,000	
Spring Pond, Dickinson		5,000	
Ohio:			
Snyder Creek, Mansfield		15,000	
Petersburg Lake, Mansfield		5,000	
Fish Pond, Athens		5,000	
Trout Pond, Mentor		5,000	
Spring Pond, near Cleveland		10,000	
Mad River, Bellefontaine		15,000	
Oregon:			
Spring Branch, Falls City			8,270
Eagle Creek, near Clackamas		12,000	
Mosher Creek, Wasco County			1,500
Mill Creek, Wasco County			1,000
Eight Mile Creek, Wasco County			1,000
Fifteen Mile Creek, Wasco County			1,000
Molton Creek, Umatilla County			3,400
Clatskanine River, Clatsop County			5,500
Clear Creek, Stone		5,069	2,500
North Fork of Santiam River, Lyons		10,000	
Tyghe Creek, The Dalles		10,000	
Butte Creek, Woodburn		10,000	
Clatskanine River, Clatskanine		15,000	
Yaquina River, Albany		10,000	
Lado Creek, Hot Lake		10,000	
McKay Creek, Pendleton		10,000	
Umatilla River, Bingham		10,000	
Spring Lake, Ashland		10,000	
Deer Lake, Oregon City		5,000	
State Fish Commission, Astoria		1,000	
Pennsylvania:			
Hartung Creek, Pottsville			400
Crane Creek, Tremont			900
Adams Creek, Tremont			400
Jeffs Creek, Tremont			600
Goldmine Creek, Tremont			700
Black Creek, Tremont			400
Middle Creek, Tremont			400
Pyne Creek, Tremont			400
Cherry Run, Lock Haven			500
Chathams Run, Lock Haven			800
Hartman Run, Lock Haven			500
Buck Hill Creek, Cresco			400
Otis Run, Riddlesburg			400
Black Lick Creek, Ebensburg			500
Davis Run, Ebensburg			950
Jones Run, Ebensburg			400
Trout Pond, Ebensburg			150
Clear Shade Creek, Johnstown			400
Potter Creek, Currys Station			400
Mountain Stream, Currys Station			400
Meadow Branch, Currys Station			400
Oriental Pond, Fairchance			300
Deer Creek, Shrewsbury			300
Hagermans Run, Williamsport			900
Rock Run, Williamsport			400
Mosquito Creek, Williamsport			900
Dry Run, Williamsport			400
Ashcroft Run, Westover			500
Mattinglys Run, Bedford			500
Blue Spring Run, Milton			300

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Pennsylvania—Continued.			
Little Chest Creek, Ebensburg			400
Lead Run, Jamison City			400
Trout Run, Jamison City			400
Fishing Creek, Jamison City			400
Breastwork Run, Stoyestown			500
Evans Run, Marietta			400
Buffalo Run, Bellefontaine			800
Spring Creek, Bellefontaine			800
Fishing Creek, Millhall			500
Remington Run, Williamsport			400
Roaring Brook, Nanticoke			400
Pikes Creek, Nanticoke			800
Fades Creek, Nanticoke			400
Black Creek, Nanticoke			400
Huntington Creek, Nanticoke			400
Wapwollepon Creek, Nanticoke			400
Badlocks Run, Nanticoke			400
Hemlock Creek, Nanticoke			400
Mountain Inn Creek, Nanticoke			400
Irish Creek, Paxinos			400
Harveys Creek, Nanticoke			400
Logans Branch, Bellefonte			600
Pine Creek, Andreas			400
Pole Bridge Creek, Laporte			400
Deep Hollow Run, Laporte			400
Starrucca Creek, Starrucca			400
Cony Creek, Starrucca			700
Spring Branch, Willow Grove			1,100
Sandy Run, Fort Washington			400
Penns Creek, Rising Spring			500
Laurel Run, Rising Spring			600
Swamp Hollow Creek, South Danville			600
Little Crossing Creek, Sinking Springs			400
Otts Run, Hopewill			400
Yellow Creek, Hopewill			500
Spruce Run, Mount Pocono			400
Trout Run, St. Marys			500
Fall Run, Nordmont			400
Hunters Run, Nordmont			300
Wilson Run, Penfield			800
Crystal Dam, Minersville			300
Indian River, Minersville			400
Tar Run, Minersville			200
Black Creek, Minersville			400
Buck Creek, Minersville			400
Swatara Creek, Minersville			400
Pulfs Springs, Ambler			300
Fish Pond, Ambler			300
Bunger Springs Pond, Ligonier			300
Bullard Creek, Troy			625
Morgan Creek, Troy			625
Wolf Creek, Mahanoy City			400
Husssosock Creek, Mahanoy City			400
Pine Creek, Mahanoy City			900
Hawks Creek, Mahanoy City			400
Rapplings Creek, Mahanoy City			400
Locust Creek, Mahanoy City			400
Swartz Creek, Pottsville			300
Cold Run, Pottsville			400
West Branch Cold Run, Pottsville			300
Tar Run, Pottsville			300
Hummels Run, Pottsville			300
Black Creek, Pottsville			400
Hunters Creek, Nordmont			300
Rock Creek, Nordmont			400
Gansell Creek, Nordmont			400
Sinking Creek, Center Hall			500
Lindemuths Creek, Gordon			500
Big Bear Creek, Hudson			500
Little Bear Creek, Hudson			500
Meadow Creek, Hudson			400
Shades Creek, Hudson			400
Rattling Run Creek, Tamaqua			400
Broad Mountain Creek, Ashland			400
Frackville Creek, Ashland			400
Stormy Creek, Rattling Run			500
Rattling Creek, Rattling Run			400
Black Creek, Rattling Run			500
Bear Run, Bear Run			500

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Pennsylvania—Continued.			
Pringle Creek, Summerhill			800
Laurel Creek, Summerhill			800
Brush Run, Altoona			500
Laurel Run, Huntingdon			500
Stone Creek, Huntingdon			500
Lake Eyr, West Chester			900
Broadhead Creek, Stroudsburg			1,500
Stony Run, Henryville			1,500
Cranberry Creek, Cresco			1,500
Paradise Creek, Mount Pocono			1,500
Bala Farm Pond, West Chester			2,000
Calkins Creek, Honesdale		20,000	
Toms Creek, Bushkill		20,000	
South Dakota:			
East Fork Spearfish Creek, Hanna		10,000	
Rapid Creek, Englewood		10,000	
False Bottom Creek, St. Onge		10,000	
Spearfish Creek, Elmore		10,000	
Beaver Creek, Spearfish		10,000	
French Creek, Custer		10,000	
South Boxelder Creek, Nemo		10,000	
East Fork Spearfish Creek, Englewood		15,000	
Boxelder Creek, Nemo		20,000	
Castle Creek, Rochford		10,000	
Fish Pond, Rochford		4,000	
Little Spearfish Creek, Elmore		10,000	
Whitman Lake, Loyalton			500
Bear Butte Creek, Pluma		10,000	
Squaw Creek, Hermosa		10,000	
Battle Creek, Hermosa		10,000	
South Boxelder, Roubaix		9,500	
Hay Creek, Roubaix		20,000	
Boxelder Creek, Roubaix		11,250	
Elk Creek, Roubaix		10,000	
Bear Butte Creek, Deadwood		10,000	
Rapid Creek, Rapid City		22,000	
Springdale Pond, Rapid City		5,000	
Spring Creek, Rapid City		10,000	
Spunk Creek, Hill City		10,000	
Spring Creek, Hill City		10,000	
Iron Creek, Hill City		10,000	
Pine Creek, Hill City		10,000	
Elk Creek, Piedmont		6,000	
White Clay Creek, Pine Ridge Agency		12,000	
Spring Creek, Whitewood		10,000	
Beaver Creek, Buffalo Gap		15,000	
Water Cress Creek, Spearfish		5,000	
Smith Branch, Spearfish		5,000	
Spearfish Creek, Spearfish		10,000	1,577
Cox Lake, Spearfish		5,000	
Montana Lake, Spearfish		10,000	
Spring Branch and Pond, Piedmont		21,000	
Blackpipe Creek Pond, Galena		5,000	
Elk Creek, Deadwood		10,000	
Tennessee:			
Stony Creek, Hunter			1,000
Roans Creek, Mountain City			9,000
Utah:			
Pincocks Springs, Ogden			2,000
Applicant, Salt Lake City	25,000		
State Fish Commission, Murray	50,000		
Vermont:			
Little Leech Pond, Averill			1,495
Shrewsbury Pond, Cuttingsville			1,495
Simpsonville Brook, Brattleboro			1,000
Frog Pond, St. Johnsbury		15,000	999
Mill Brook, Windsor			1,200
Cleveland Brook, Bethel			1,000
Mud Pond, Randolph			800
Trout Brook, Pittsford			995
Pond and stream, West Hartford			1,600
Brookfield Branch, Randolph			1,000
Tributary of Reach Brook Creek, Essex County		20,000	
Fletcher Brook, Lyndonville		20,000	
Walker Quarry and Stepler Creek, Williamstown		20,000	
Trout Brook, Northfield		15,000	
Wardners Pond, Montpelier		10,000	
Nigger Head Pond, Montpelier		20,000	
Langdon Pond, Montpelier		15,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Vermont—Continued.			
Yatter Pond, Montpelier		10,000	
Bennett Brook, Montpelier		20,000	
Hobart Brook, Montpelier		20,000	
Ice Pond, Brattleboro			1,000
Spring Branch, Randolph			1,000
Jones Brook, Braintree		20,000	1,000
Ballore Creek, Wilmington			990
Mills Brook, Barre		15,000	
Burroughs Brook, St. Johnsbury		15,000	
Spring Brook, St. Johnsbury		5,000	
Watermans Branch, Johnson		20,000	
Tributary of Granby Brook, Gallups		25,000	
Black Pond, Woodstock		15,000	
Cold Brook, Brattleboro		25,000	
Lake Lakota, Woodstock		20,000	
Tucker Brook, Woodstock		10,000	
Salmon Brook, Dummerston		25,000	
Passumsic River, Lyndonville		30,000	
Ferrin Creek, Island Pond		20,000	
Willington Brook, Randolph		15,000	1,000
Pond and brook, Randolph		15,000	
Ayers Brook, Randolph		25,000	
Peth Brook, Randolph		20,000	
Hatch Pond, Randolph		15,000	
Mill Brook, Windsor		25,000	
Williams River, Proctorville		25,000	
West Branch Williams River, Chester		15,000	
South Branch Williams River		20,000	
Whetstone Brook, Brattleboro		15,000	
Marlboro Pond, Brattleboro		10,000	
Coane Brook, Brattleboro		20,000	
Summit Pond, Summit		10,000	
Branch White River, Williamston		25,000	
East Roxbury Pond, Montpelier		10,000	
Amponpanoosic River, Sharon		30,000	
Keyes Brook, Sharon		10,000	
Barney Brook, Westminster		10,000	
Governors Brook, Westminster		10,000	
Mill Brook, Westminster		10,000	
Battenkill River, Manchester		30,000	
Fish Pond and stream, West Hartford		15,000	
Pico Lake, Rutland		24,287	
Darling Pond, Groton		60,000	
Lake Mansfield, Stowe		60,000	
Waterbury		60,000	
Lake Mitchell, West Norwich		140,000	
Darling Pond, Westville		57,000	
State Fish Commission, Roxbury		5,000	
Virginia:			
Snake Den Creek, Hunters			4,000
Matthews Lake, Martinsville			125
Sweet Run, Loudoun County			500
Falls Branch, Oak Ridge			800
Fox Creek, Troutdale			15,200
Tates Run, Wytheville			460
Ogle Creek, Dunlap		45,000	
Tributaries of Difficult Run, Hunters			1,423
Little River, Grayson County			1,000
Falling Spring Branch, Covington		30,000	
Spring Branch, Wrights Siding		5,000	
Laurel Run, Covington		25,000	
Castcel Run, Covington		25,000	
Little Creek, Burkes Garden		5,000	
Washington:			
Wagner Lake, Wilbur			800
Martins Lake, Springdale			800
San Poil Lake, Republic			800
Pond and stream, Newport			1,000
Spring Branch, North Yakima			7,500
Jones Lake, Yakima			500
Fish Pond, Cheney			800
Spokane			500
Valley			500
Bear Creek and French Lake, Milan			1,500
Spring Brook, Milan			1,500
Mirror Lake, Meyers Falls			1,800
Spring Brook, Snohomish		5,000	
Fish Pond, Seattle		8,000	
Summit Lake, Woodenville		5,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Washington—Continued.			
West Fork White Salmon River, Klickitat County		12,000	
Crab Creek, Harrington		10,000	
Arkansaw Creek, Castle Rock		10,000	
Lake Blackman, Snohomish		10,000	
Trout Lake, Spokane		8,000	
O'Brien Creek, Republic		15,000	
San Poil Creek, Republic		5,000	
West Virginia:			
Mountain Creek, Capon Springs			800
Trout Run, Romney			600
Bluestone Creek, Hinton			5,000
Glade Creek, Talcott			5,000
Mill Creek, Alderson			5,000
Fish Pond, Gladwin			200
Haddix Creek, Moore			3,000
Mill Creek, Fayette			3,950
Spring Pond, Eglon			300
Fish Ponds, Eglon			900
Bush Lake, Eglon		18,000	
Meadow Run, Durbin		50,000	5,000
East and west branch of Greenbrier River, Durbin		25,000	4,950
Tygarts Valley River, Grafton			450
Valleyfalls			150
Clover Lick Creek, Cloverlick			2,000
Mouth Cherry River, Curtin			1,000
Cranberry River, Cranberry			2,800
Gauley River, Richwood			2,500
Spring Branch, White Sulphur Springs		73,000	2,000
Howard Creek, White Sulphur Springs			2,348
Small Creek, Gladwin		4,500	
Leetown Run, Shenandoah Junction			400
North Fork Blackwater Creek, Thomas		19,000	
Big Clear Creek, Rupert		50,000	
Meadow Creek, Shryock		25,000	
Milligan Creek, Bungers		15,000	
Head of Glade Creek, Hinton		25,000	
Wisconsin:			
Prairie River, Merrill			500
Beargrass River, Fallcreek			250
Moores Creek, Norwalk			400
Rock Creek, Eau Claire			200
Coon Creek, Eau Claire			200
Fourmile Creek, Barron			250
North Branch, La Crosse			250
Halfway Creek, La Crosse			250
Burham Creek, La Crosse			250
Richmond Creek, La Crosse			250
Sand Creek, Cartwright			250
Hay Creek, Chippewa Falls			250
Beef River, Fairchild			500
Scotts Creek, Fairchild			250
Badleys Creek, Fairchild			250
Beaty Creek, Hixton			300
South Branch Creek, Hixton			300
North Branch Creek, Hixton			300
Tank Creek, Hixton			300
Lome Creek, Hixton			300
Clear Creek, Eau Claire			200
Elk Creek, Eau Claire			450
Otter Creek, Eau Claire			250
Lowes Creek, Eau Claire			250
North Branch Owen Creek, La Crosse			250
Crolls Creek, La Crosse			250
Fishback Creek, La Crosse			250
Krauls Creek, La Crosse			250
Trout Creek, Millston			300
Stony Creek, Millston			250
Cowles Creek, Arcadia			300
Duncan Creek, Chippewa Falls			250
Traves Valley Creek, Independence			300
Douglas Creek, Black River Falls			250
Clear Creek, Black River Falls			250
Roaring Creek, Black River Falls			250
Slauser Creek, Black River Falls			250
Papoose Creek, Black River Falls			450
Van Herset Creek, Black River Falls			250
Town Creek, Black River Falls			200
Squaw Creek, Black River Falls			200
Trout Run, Black River Falls			200
Kenyon Creek, Black River Falls			200

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Brook trout—Continued.			
Wisconsin—Continued.			
Perrys Creek, Black River Falls			200
Allens Creek, Black River Falls			200
Snow Creek, Black River Falls			200
South Branch of Levis Creek, Black River Falls			200
White River, Neshkoro		5,500	
Gilbert Creek, Menomonie		7,000	
Little Elk Creek, Menomonie		5,000	
White River, Wautoma		5,500	
Emmons Creek, Waupaca		4,500	
Pine River, Wildrose		6,500	
Bostwic Creek, La Crosse		3,500	
Chipmunk Creek, La Crosse		3,500	
State Road Cooley Creek, La Crosse		3,500	
Mormon Cooley Creek		5,000	
South Cooley Creek		3,500	
Gills Cooley Creek		3,500	
Halfway Creek, La Crosse		4,500	
Centerville Creek, La Crosse		4,500	
Mormon Spring Creek, La Crosse		3,500	
Adams Valley Creek, La Crosse		3,500	
Dutch Creek, La Crosse		3,500	
Brown Creek, Augusta		4,000	
Sand Creek, Augusta		5,000	
Mullett River, Plymouth		5,000	
Lousy Creek, Menomonie		5,000	
Deer Creek, Durbrook		6,000	
Halls Lake, Alma Center		3,500	
Reefer Creek, Orienta		5,000	
Trout Creek, Alma		4,500	
Irving Creek, Menomonie		6,000	
Applicant, Osceola	20,000		
Wyoming:			
Fish Lake, Gillette			800
Green Mountain Springs, Inyankara			1,500
Sand Creek, Beulah		15,000	
Red Water River, Aladdin		10,000	
Japan:			
British Minister, Tokyo	25,000		
Argentina:			
Argentine Government	100,000		
Total	541,000	7,221,536	842,452
Lake trout.			
Colorado:			
Trout Pond, Glenwood Springs			24
Connecticut:			
State Fish Commission, Windsor Locks	200,000		
Michigan:			
State Fish Commission, Sault Ste. Marie	2,300,000		
Long Lake, Alpena		30,000	
Brush Lake, Hillman		30,000	
Lake Superior, Marquette		1,020,000	
off Long Point, Isle Royale		320,000	
Washington Harbor, Isle Royale		320,000	
Rock Harbor, Isle Royale		280,000	
Todd Harbor, Isle Royale		280,000	
Tobins Harbor		360,000	
Eagle Harbor		320,000	
Ontonagon		640,000	
Fish Island		240,000	
Whitefish Point		500,000	
Lake Michigan, off Charlevoix		1,250,000	
Irishmans Reef, off Charlevoix		1,250,000	
Manistique		500,000	
Lake Huron, off Scarecrow Island		1,090,000	
Presque Isle		550,000	
North Point		550,000	
Minnesota:			
Lake Alexandria, Littlefalls		15,000	
Leech Lake, Walker		25,000	
Lake Superior, Grand Marais		360,000	
Grand Portage		360,000	
Chicago Bay		360,000	
Beaverbay		265,000	
off Poplar River		265,000	
French Creek		180,000	
Two Harbors		180,000	
Mouth of Lester River		100,000	
Duluth			8,200

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Lake trout—Continued.			
Missouri:			
Louisiana Purchase Exposition, St. Louis			181
New Hampshire:			
Partridge Lake, Littleton		15,000	
Crystal Lake, West Canaan		20,000	
First Connecticut Lake, Beecher Falls		30,000	
State Fish Commission, Laconia	100,000		
Forest Lake, Littleton		20,000	
Loon Lake, Center Ossipee		20,000	
Newfound Lake, Bristol		34,000	
New York:			
State Fish Commission, Caledonia	200,000		
New York City Aquarium	10,000		
Otsego Lake, Cooperstown		35,000	
Lake Ontario, Trout Hole, off Cape Vincent		1,250,000	
off Grenadier Island		1,450,000	
Trout Hole, off Charity Shoals		850,000	
off Tibbetts Point Light		250,000	
off Oneills Point		635,000	
Ohio:			
Big Lake, Urbana			1,800
Lake Erie, off Kelleys Island		884,000	
Oregon:			
Clackamas River, Clackamas			21,626
Sucker Lake, Oswego			10,000
Jordan and Perkins Lakes, Marshfield		20,000	
Pennsylvania:			
State Fish Commission, Corry	200,000		
Vermont:			
Big Averill Lake, Norton		20,000	
Washington:			
Deep Creek Lake, Northport			2,000
Pierre and Summit Lakes, Orient		19,980	
Steilacoom Lake, Lake View		40,280	
Wisconsin:			
Butternut Lake, Three Lakes		10,000	
Sugar Camp Lake, Rhinelander		10,000	
Lake Superior, off Madeline Island		350,000	
Sand Island		316,200	
Bark Bay		265,000	
Rossport		300,000	
Big Creek, Molleyville		2,000	
Argentina:			
Argentine Government	50,000		
Total	3,060,000	18,486,460	43,831
Golden trout.			
Maine:			
Canaan Lake, Rockland		5,000	
Nortens Lake, Rockland		5,000	
Moostocmaguntic Lake, Oquossoc		5,000	
China Lake, Waterville		5,000	
Missouri:			
Louisiana Purchase Exposition, St. Louis			30
New Hampshire:			
Lake Sunapee, Lake Sunapee		16,000	
Total		36,000	30
Canadian red trout.			
Missouri:			
Louisiana Purchase Exposition, St. Louis			13
Grayling.			
California:			
State Fish Commission, Sisson	100,000		
Colorado:			
South Platte River, Florissant		10,000	
Los Pinos Creek, Osier		10,000	
South Platte River, Altruria		10,000	
Grizzley Creek, Glenwood Springs		10,000	
Frying Pan River, Ivanhoe		10,000	
Idaho:			
Maize Lake, Hailey		50,000	
Crystal Lake, Hailey		50,000	
Michigan:			
State Fish Commission, Harris	100,000		
Missouri:			
Louisiana Purchase Exposition, St. Louis	38,000		255
State Fish Commission, St. Joseph	46,000		

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Grayling—Continued.			
Montana:			
Fish Ponds, Anaconda		150,000	
Flathead River, Kalispell		50,000	
Stillwater River, Kalispell		50,000	
Beaver Creek, Havre		50,000	
Bridger Creek, Gallatin County		100,000	
Lyman Creek, Gallatin County		100,000	
Box Elder Creek, Havre		100,000	
Dupuyer Creek, Conrad		100,000	
Elk Creek and tributaries, Red Rock Lake		1,753,650	
New Hampshire:			
Pond and streams, Potter Place		10,000	
Tributaries of Sugar River, Newport		10,000	
Beaver Brook, West Windham		10,000	
Swift Diamond Creek, Colebrook		10,000	
Oregon:			
South Fork Walla Walla River, Milton		15,000	
North Fork Walla Walla River, Milton		15,000	
Walla Walla River, Milton		15,000	
Collins Creek, Albany		3,550	
Wyoming:			
State Fish Commission, Sheridan	50,000		
Total	334,000	2,692,200	255
Lake herring.			
Ohio:			
Lake Erie, off Middle Island		5,000,000	
Kelleys Island		5,000,000	
Put-in Bay		13,300,000	
Total		23,300,000	
White-fish.			
Michigan:			
Crystal Lake, Beulah		1,000,000	
Long Lake, Battle Creek		200,000	
Lake Superior, Marquette		4,200,000	
Ontonagon		4,200,000	
Whitefish Point		9,000,000	
Lake Huron, Sturgeon Point		5,000,000	
Thunder Bay		5,000,000	
North Point		15,000,000	
Scarecrow Island		5,000,000	
Lake Michigan, Charlevoix Reef		23,000,000	
off Fishermans Island		3,000,000	
head of Beaver Island		3,000,000	
St. Marys River, Sault Ste. Marie		1,000,000	
Detroit River, off Belle Isle		27,800,000	
Minnesota:			
Lake Superior, off mouth of Lester River		1,600,000	
New York:			
State Fish Commission, Caledonia	2,000,000		
New York City Aquarium	10,000		
Otsego Lake, Cooperstown		435,000	
Lake Ontario, off Tibbetts Point Light		4,300,000	
Charity Shoals		2,000,000	
Grenadier Island		2,000,000	
Newfound Shoals		2,500,000	
Pigeon Island		2,000,000	
Van Schaick Shoals		1,000,000	
South Bar, West End		1,000,000	
Ohio:			
Lake Erie, Ballast Island Reef, Put in Bay		10,000,000	
near Lutes Point, Put in Bay		10,000,000	
Middle Island, off Kelleys Island		10,000,000	
near Gull Island, off Kelleys Island		5,000,000	
off Kellys Island		8,250,000	
North Bass Reef, off Put-in Bay		10,000,000	
Pennsylvania:			
State Fish Commission, Erie	46,280,000		
Wisconsin:			
State Fish Commission, Mineral Point	10,000,000		
England:			
Applicant, Malvern Wells	25,000		
New Zealand:			
New Zealand Government	1,000,000		
Argentina:			
Argentine Government	1,000,000		
Total	60,315,000	176,485,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pike perch.			
Connecticut:			
Brookside Lake, Winsted		300,000	
Taunton Lake, Bethel		500,000	
District of Columbia:			
Potomac River, off Three Sisters		833,000	
Indiana:			
West Fork, White River, Indianapolis		1,000,000	
Pretty Lake, Plymouth		300,000	
Pine Lake, La Porte		300,000	
Lake Gage, Angola		600,000	
Crooked Lake, Angola		500,000	
Silver Lake, Angola		300,000	
Stone Lake, Angola		300,000	
Lake Maxinkuckee, Culver		7,700,000	
Goose Lake, Columbia City		200,000	
Pleasant Lake, Pleasant Lake		300,000	
Iowa:			
Upper Iowa River, Chester		800,000	
Cedar River, Waterloo		1,000,000	
Kentucky:			
Kinnikonnick River, Vanceburg		1,000,000	
Appletree Reservoir, Stearns		875,000	
Massachusetts:			
State Fish Commission, Wilkinsonville	5,000,000		
Michigan:			
Lake Antoine, Iron Mountain		300,000	
Pleasant Lake, Edwardsburg		500,000	
Pine Lake, Allegan		300,000	
Long Lake, Manistee Junction		500,000	
Hamlin Lake, Ludington		1,000,000	
State Fish Commission, Detroit	47,495,000		
Minnesota:			
Eagle Lake, Willmar		300,000	
Horse Shoe Lake, Carson		300,000	
Swan Lake, Fergus Falls		200,000	
Long Lake, Fergus Falls		300,000	
White Earth Lake, White Earth		650,000	
Green Lake, Chisago City		300,000	
Missouri:			
Louisiana Purchase Exposition, St. Louis	12,000,000		
State Fish Commission, St. Joseph	10,000,000		
New Hampshire:			
Swanzey Pond, West Swanzey		300,000	
Emerson Pond, Westrindge		300,000	
New Jersey:			
Bear Pond, Netcong		833,000	
New York:			
St. Lawrence River, mouth Scotch Brook		100,000	
North Dakota:			
Cold Lake, Underwood		75,000	
Painted Woods Lake, Washburn		225,000	
Ohio:			
Auglaize River, Wapakoneta		2,500,000	
Tuscarawas River, Isleta		2,500,000	
Muskingum River, Marietta		1,250,000	
Lake Erie, North Bass Reef, off Put-in Bay		25,000,000	
Stones Cove, off Put-in Bay		10,000,000	
School House Reef, off Put-in Bay		15,000,000	
School House Reef, off Put-in Bay		23,400,000	
School House Reef, off Catawba Island		15,000,000	
Niagara Reef, off Port Clinton		15,000,000	
Gull Island Reef, off Kelleys Island		15,000,000	
Pennsylvania:			
State Fish Commission, Erie	35,000,000		
South Dakota:			
Lake Poinsett, Estilline		500,000	
Vermont:			
Rescue Pond, Ludlow		300,000	
Galusha Pond, Montpelier		300,000	
Lake Bomoseen, Fairhaven		500,000	
Derby Pond, Newport		300,000	
Black River, Hardwick		500,000	
Winooski River, Winooski		1,250,000	
Missisquoi River and Bay, Swanton		2,000,000	
Swanton		8,000,000	
High Gate Springs		1,500,000	
Lake Champlain, Missisquoi Bay		3,000,000	
Goose Bay		3,500,000	
Gander Bay		2,000,000	
Swanton		3,285,000	

Details of distribution—Continued.

Species and disposition.	Eggs.	Fry.	Fingerlings, yearlings, and adults.
Pike perch—Continued.			
Vermont—Continued.			
Lake Champlain, St. Albans Bay		2,000,000	
McQuan Bay		1,250,000	
Otter Creek, Vergennes		500,000	
Virginia:			
Meherrin River, Emporia		830,000	
West Virginia:			
Ohio River, Sistersville		1,250,000	
Wisconsin:			
Diamond Lake, Drummond		200,000	
Kleuths Lake, Medford		200,000	
Sackets Lake, Medford		200,000	
Niger Lake, Medford		200,000	
School House Lake, Medford		200,000	
Total	109,495,000	181,706,000	
Yellow perch.			
Iowa:			
Maquoketa River, Manchester		25,000	
Maryland:			
Potomac River, off Bryan Point		878,000	
Swan Creek		1,040,000	
Piscataway Creek		2,275,000	
Pamunkey Creek		3,250,000	
Virginia:			
Potomac River, Little Hunting Creek		2,600,000	
off Dove Creek		3,705,000	
Pohick Creek		2,080,000	
Occoquan Bay		7,410,000	
Total		23,263,000	
White perch.			
Maryland:			
Chesapeake Bay, Battery Shoals		2,450,000	
Western channel		1,500,000	
Eastern channel		9,100,000	
Swan Creek, Swan Creek		14,400,000	
Mill Creek, Mill Creek		1,900,000	
Total		29,350,000	

Species and disposition.	Fingerlings, yearlings, and adults.
Catfish.	
Alabama:	
Fish Pond, Guin	1,000
Hooks	1,000
Arkansas:	
Fish Pond, Johnson	60
Georgia:	
Fish Pond, Flippen	1,000
Lovejoy	1,000
Milner	500
The Rocks	500
Stinson	50
Warm Springs	25
Willacoochee	100
Chipley	50
Malier's Pond, Sunnyside	1,000
Mill Pond, Decatur	50
Lake Mohignac, Columbus	150
Little River, Crawfordsville	50
Indiana:	
Fish Pond, Haubstadt	50
Fork of Wild Cat Creek, Rossville	50
Faw Lake, Indianapolis	50
Kansas:	
Fancy Lake, Coldwater	20
Fish Pond, Coldwater	20
Middle Kiowa Creek, Mullinsville	25
Little Driftwood Creek, Kiowa	55
Gungan Pond, Chetopa	20
Catfish—Continued.	
Kansas—Continued.	
Fish Pond, Wichita	25
Argonia	15
Kentucky:	
Pond No. 1, Beaverdam	50
Dewey Pond, Mentor	48
Fish Pond, Lexington	96
Hunters Depot	50
Louisiana:	
Fish Pond, Crowley	150
Mississippi:	
Adair's Pond, Maben	50
Missouri:	
Fish Pond, Mansfield	30
Louisiana Purchase Exposition, St. Louis	35
North Carolina:	
Trentman Creek, Walnut Cove	200
Catawba River, Mount Holly	200
Nolichucky River, Pigeon Roost	3,000
Fish Pond, Charlotte	200
Burgaw	200
North Dakota:	
Round Lake, Rhodes	300
Curlew Creek, Glenullin	200
Ohio:	
Hoffarths Pond, Delhi	48
Norris Pond, Norwalk	75
Lake Pippin, Akron	75

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Catfish—Continued.	
Ohio—Continued.	
Auglaize River, Wapakoneta	100
St. Joseph River, Montpelier	200
Oklahoma:	
Fish Pond, Okarchee	200
Mulhall	50
Blackwell	20
Stillwater	100
Three Ponds, Oklahoma City	150
Pennsylvania:	
Fish Pond, Washingtonville	275
Chambersburg	50
South Carolina:	
Mill Pond, Greenville	200
Fish Pond, Williston	1,000
Trenton	1,000
Fountain Inn	300
South Dakota:	
Fish Ponds, Ipswich	400
Lake Kampeska, Watertown	400
Tennessee:	
Fish Ponds, Gibson	150
Medina	50
Collinsville	50
Fayetteville	200
Brentwood	25
LimestoneSpring, Mountain City	200
Armstrong Pond, Columbia	25
Spring Branch, Fishery	13
Texas:	
Six Mile Tank, Decatur	100
Fish Ponds, Santa Anna	75
Fair Grounds Pond, San Antonio	100
Railroad Lake, Irene	160
Belle Branch	162
Virginia:	
Anderson's Pond, Martinsville	200
Total	17,857
Large-mouth black bass.	
Alabama:	
Fish Pond, Florence	2,000
Allenton	400
Dickinson	500
Brantley	800
Guin	500
Kingston	300
Mobile	500
Cottonton	500
Seale	1,600
Sawyersville	500
Haleysville	500
Fish Lake, Lincoln	1,000
Russellville	600
Birmingham	1,000
McIntosh Pond, Enterprise	700
Little Sniff Lake, Selma	800
Rocky Hill Lake, Courtland	800
Pitts Pond, Pittsboro	500
Whetstone Lake, Montgomery	2,000
Spring Pond, Brantley	500
Hurricane Branch, Atmore	1,000
Beasley Pond, Clayton	500
Coone Pond, Lowndesboro	500
Turners Pond, Selma	500
Lake Como, Birmingham	1,000
East Lake, Birmingham	800
Cypress Creek, Florence	2,000
Sand Cut Pond, Eufaula	500
Ossipeippa Creek, Cusseta	1,000
Phillips Pond, Cuba	500
Spring Branch Pond, Atmore	500
Craddock Pond, Dadeville	500
Edmonds Mill Pond, Ozark	500
Bridges Fish Pond, Jasper	1,000
Woods Pond, Berlin	1,000
Pearces Mill Pond, Seale	800
Eight Mile Creek, Cullman	1,000
Small Creek, Cullman	1,000
Black bass—Continued.	
Alabama—Continued.	
Mill Brook, Madison	1,000
Wiggins Spring Brook, Madison	1,000
Clear Creek, Jasper	1,000
Bay Branch Pond, Andalusia	500
Stone Creek, Blount Springs	1,000
Rosemont Pond, Demopolis	200
Sucarnoochee Creek, Livingston	1,000
Crooked Creek, Sylacauga	900
Arizona:	
Silver Creek, Holbrook	100
Morgan Lake, Phoenix	50
La Laguna Pond, Benson	50
Sisson Pond, Safford	40
Jones Reservoir, Safford	40
Fish Pond, Benson	50
Benson	50
Pecks Lake, Jerome	100
Verde River, Jerome	150
San Francisco River, Clifton	150
Arkansas:	
St. Francis River, Pickett	200
Willow Pond, Malvern	80
McHenry Pond, Malvern	200
West Fork White River, Brentwood	250
West Fork White River, Fayetteville	275
Illinois River, Fayetteville	300
Mill Pond, Benton	40
Connecticut:	
Slater Pond, Chester	100
Delaware:	
Mill Lake, Milford	200
Ingrams Mill Pond, Milton	200
Chesapeake and Delaware Canal, Delaware City	200
Denton Fish Pond, Broadkill	200
Fish ponds, Wilmington	600
Florida:	
Blue Lake, De Land	1,800
Sand Lake, Orlando	200
Cypress Lake, Cypress	150
Dalis Pond, Leroy	500
Fish Pond. Leroy	500
Green Cove Spring	300
Georgia:	
Sun Set Lake, Lakepark	150
Fish Pond, Hephzibah	1,000
Thomaston	500
Milledgeville	100
Jesup	125
Woolsey	200
Summerville	1,300
Comer	500
Paschal	1,000
Nickville	500
Tate	500
Lavonia	500
McDonough	500
Duluth	800
Sycamore	1,000
Cedartown	800
Renfroe	500
Fashion	1,800
Thomaston	800
Eastman	800
Renfroe	500
Clarkesville	1,000
Hall Pond, Thomasville	100
Deep Creek, Clarkesville	400
Sanders Fish Pond, Whiteplains	100
Long Fish Pond, Whiteplains	100
Reservoir, Milledgeville	100
Nelson Mill Pond, Macon	150
Martins Pond, Milner	200
Flint River, Jonesboro	200
Spring Creek, Willacoochee	125
Little River, Buchanan	200
McCalls Mill Pond, Macon	1,000

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Georgia—Continued.	
Stephens Pond, Kite	800
Branch Pond, Tarrytown	500
Branch Head Pond, Higgston	800
Crystal Lake, Tunnelhill	1,500
Town Creek Pond, Oglethorpe	800
Kings Pond, Cusseta	200
Carr Mill Pond, Zenith	1,000
Tallapoosa River, Carrollton	2,000
Fish Lake, Summerville	1,000
Spring Lake, Catoosa County	1,000
East Branch, Harrel Creek, Mountairy	1,000
Mill Pond, Tunnelhill	1,500
Barnes Pond, Harris	500
Williams Creek, Lyons	1,000
Sterns Pond, Williamson	800
Wildwood Lake, Columbus	800
Waterworks Pond, Columbus	800
Marietta	1,000
Spalding Ponds, Griffin	1,500
Wards Gin Pond, Cuthbert	500
Polecat Lake, Tate	1,000
Whitfield Pond, Tate	500
Lake, Tate	1,000
Crooked Creek Lake, Tate	500
East Lake, Atlanta	1,000
Bells Mill Pond, Cuthbert	200
Pine Lake, Duluth	1,000
Shoal Creek, Canton	1,000
Hickory Log Creek, Canton	1,000
Spring Creek, Rome	2,000
Tates Mill Pond, Jasper	2,000
Lake Cohutta, Dalton	800
Mill Pond, Augusta	800
Tilton	1,000
Deep Creek, Clarkesville	1,500
Hemptown Creek, Jasper	1,000
Fish Lake, Atlanta	500
Holly Creek, Dalton	1,500
Parham Pond, Norwood	500
Bradshaw Pond, Norwood	500
Grays Pond, Haralson	1,000
Beech Creek, Lagrange	2,000
Childs Pond, Newborn	1,000
Mill Pond, Meansville	1,000
Harpers Pond, Eastman	800
Buchanan Pond, Eastman	500
Moons Pond, Powder Springs	500
Apalachee River, Bethlehem	1,000
Spring Branch, Eupatoie	500
Chattahoochee River, Gainesville	1,000
Tallapoosa River, Buchanan	1,000
Oconee River, Commerce	1,000
Mill Branch, Nicholls	800
Massus Creek, Rockledge	600
Lakewood Lake, Atlanta	500
Roberts Pond, Fairburn	500
Illinois:	
Snowflake Pond, Dahlgren	80
Fairgrounds Lake, Springfield	240
Sangamon River, Decatur	360
Fairlawn Lake, Decatur	100
Springdale Lake, Oakland	80
Reservoir Lake, Paris	200
Miller Park Lake, Bloomington	100
Brickyard Pond, Collinsville	208
Fish Pond, Farmer City	100
Gibson	100
Marshall Pond, Whitehall	40
Suburban Lake, Whitehall	40
Meredosia Bay, Meredosia	1,700
Monee Reservoir, Monee	240
Kinmundy Reservoir, Kinmundy	120
Bois Reservoir, Bois	120
Coulterville Reservoir, Coulterville	120
Black bass—Continued.	
Indiana:	
Martin Fish Pond, Muncie	160
Fish Pond, Bloomington	160
Portland	135
Daleville	80
Fort Wayne	150
Fish Lakes, Indianapolis	120
Pine Creek, Williamsport	320
Big Pine Creek, Williamsport	160
Blue Lake, South Bend	200
Heaton Lake, Elkhart	500
Johnsons Pond, Brazil	150
Trager Pond, Bristol	300
Big Indian Creek, Georgetown	500
Lost River, Orleans	160
Buck Creek, New Albany	150
Spring Branch Pond, Rivervale	80
Spring Lake, Anderson	80
Gravel Pit, Greentown	140
Hartman Lake, Kendallville	250
Warren Park Ponds, Terre Haute	75
Crystal Lake, Anderson	80
Tippecanoe River, Monticello	150
Lake, Leesburg	150
River, Rochester	300
Silver Lake, New Albany	150
Silver Creek, Memphis	100
North Fork White River, Broadripple	160
North Fork, Wild Cat Creek, Rossville	500
Whitewater River, Centerville	200
Fall Creek, Pendleton	80
Glendale Pond, Anderson	80
Waterworks Lake, Huntingburg	80
Willow Lake, Evansville	120
Lake Manitou, Rochester	200
Sand Creek, Leets	200
Lagoon Park Pond, Portland	90
White River, Muncie	160
Winchester	160
Broadripple	160
Eel River, Jamestown	200
Salomonia River, Portland	135
South Fork Wild Cat Creek, Mulberry	150
Driftwood Creek, Edinburg	100
Lake Wawassee, Wawassee	300
Winona Lake, Warsaw	500
Pigeon Creek, Booneville	150
Country Club Lake, Evansville	280
Big Creek, North Madison	140
Cole Creek, Veedersburg	140
West Fork White River, Indianapolis	700
Mill Pond, Mount Vernon	80
Wellfred Fish Pond, Shelburn	225
Magner Pond, Orleans	80
Applicants in Indiana	890
Indian Territory:	
Fish Ponds, Cherokee Nation	1,000
Ardmore	375
Coal Pond, Pauls Valley	75
Washita River, Pauls Valley	150
Lancaster Lake, Ardmore	75
Pennington River, Tishomingo	75
Chickasaw Lake, Ardmore	75
Lynch Lake, Vinita	100
Fish Lake, Choteau	70
Tucker Lake, Chickasha	75
Reservoir, Byers	150
Risner Lake, Atoka	35
Applicants	150
Kansas:	
Caney River, Grenola	1,500
Slate Creek, Wellington	200
Fall River, Neodesha	1,500
Caldwell	100

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Kansas—Continued.	
Lake Juanita, Geuda Springs	50
Fish Pond, Goddard	40
Bronson	500
Railroad Lake, Cherokee	1,000
Bass Lake, Rago	75
Grouse Creek, Burden	100
Walnut River, Douglass	100
Eldorado	100
Spring Branch, Bronson	500
Dutch Creek, Wilmot	100
Limestone Creek, Bronson	500
Bass Pond, Bronson	500
Farm Pond, Oswego	500
City Water Ditch Lake, Medicine Lodge	500
Sugar Lake, Medicine Lodge	40
Fairley Lake, Medicine Lodge	40
Bentley Pond, Belmont	35
Marmaton River, Fort Scott	500
Valks Lake, Pratt	25
Gibson Pond, Isabel	35
Small Lake, Anthony	75
Gates Pond, Anthony	50
Cedar Mountain Pond, Sharon	100
Applicants	450
Kentucky:	
Kings Pond, Burgin	40
West Fork Creek, Trenton	100
Distillery Lake, Eminence	80
Fish Pond, Samuels	150
Allensville	120
Paris	120
Trenton	425
Paris	320
Keene	40
Hodgensville	150
Linn Pond, Linn	80
Lake View, Latonia	80
Spring Lake, Allensville	320
Lake Reba, Richmond	120
Sanfords Pond, Campbellsburg	80
Benson Creek, Frankfort	120
Middle Fork Red River, Natural Bridge	560
Tygarts Creek, Olivehill	120
Weare Fish Pond, Trenton	50
Willow Pond, Allensville	160
Stoner Creek, Austerlitz	200
Sidney Clay Pond, Paris	80
Strodes Creek, Paris	160
Wright Pond, Paris	120
Clear Pond, Newstead	100
Elk Fork Creek, Guthrie	150
Rock Wall Pond, Julian	50
Faulkner Pond, Rich	100
Casey Creek, Newstead	200
Candle Pond, Newstead	100
Buck Pond, Newstead	100
Boyd Lake, Shelbyville	80
Glenns Pond, Shelbyville	80
Zaring Pond, Shelbyville	80
Beshears Creek, Shelbyville	80
Fox Run, Shelbyville	80
Mulberry Creek, Shelbyville	80
Daniels Pond, Shelbyville	80
Offutt Lake, Shelbyville	80
Lake Ellerslie, Lexington	480
Hall Pond, Newstead	100
Fleming Creek, Pleasant Valley	280
Perrine Pond, Maysville	40
Big Pond, Trenton	100
Kinniconick River, Vanceburg	120
Clearview Lake, Austerlitz	80
Slate Creek, Mount Sterling	480
Luebegond Creek, Mount Sterling	160
Mount Sterling Lake, Mount Sterling	240
Kentucky—Continued.	
Wooldridge Pond, Versailles	80
Triplet Creek, Morehead	160
Bowman Pound, Burgin	40
Kingfisher Lake, Powers	120
Big Sandy River, Louisa	120
Applicants	1,575
Louisiana:	
Stokes Pond, Mansfield	40
Lake Hayes, Lake Hayes	400
Artificial Lake, Bowie	120
Natchitoches	40
Lumber Company Pond, Marthaville	70
Red Bayou, Gillian	80
Fish Lake, Natchitoches	40
Robeline	70
Loring	40
Champlin Lake, Natchitoches	120
Scarbrough Lake, Natchitoches	40
Spring Branch, Natchitoches	40
Harts Island Bayou, Shreveport	70
Moon Lake, Taylortown	80
Lake Tasse, Cave	350
City Park Lake, New Orleans	200
Mississippi River, New Orleans	80
Mill Pond, Warnerton	1,000
Ferguson Lake, Homer	37
Applicants	110
Maine:	
Lower Kimball Pond, Fryeburg	348
Maryland:	
Noyes Dam, Gaithersburg	750
Eastern Branch, Riverdale	100
Fishing Creek, Frederick	1,423
Waterworks Pond, Smithburg	500
Deep Creek, Deer Park	300
Piney Falls Creek, Frederick	200
Magathy River Jones	200
Potomac River, Cumberland	500
Rawlings	4,500
Conococheague Creek, Hagerstown	2,200
Flag Pond Creek, Doubs	800
Gwyns Falls Creek, Catonsville	250
Chevy Chase Lake, Chevy Chase	60
Massachusetts:	
Connecticut River, Northampton	400
Onota Lake, Pittsfield	200
Comet Pond, Hubbardston	300
Fish Pond, Northampton	100
Hubbardston	100
Craigs Pond, Peabody	200
Chartley Pond, Chartley	200
Michigan:	
Susan Lake, Charlevoix	200
Lake Fremont, Fremont	300
Glen Lake, Empire	200
Hogs Back Lake, Traverse City	200
Van Auckins Lake, Hartford	200
Christiana Pond, Edwardsburg	200
Round Lake, Hanover	200
Whites Lake, Kalamazoo	200
Crooked Lake, Oden	200
Eagle Lake, Edwardsburg	200
Small Lake, Hart	250
Mississippi:	
Fish Ponds, Bolton	2,000
Myrtle	40
Starkville	240
Ellisville	2,000
Corinth	240
Clinton	1,000
Edwards	1,000
Estabutchie	1,000
Macon	80
Rienzi	40
Iuka	800

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Mississippi—Continued.	
Horseshoe Lake, Aberdeen	120
Holmes Lake, Brandon	1,000
Horseshoe Lake, Abbeville	180
Spring Branch, Myrtle	75
Collins Pond, Myrtle	76
Banks Pond, Hernando	85
Fresh Water Ponds, Gloster	7,000
Rose Farm Fish Pond, Ocean Springs	150
Dead River, Aberdeen	135
Fish Lakes, Corinth	340
Mooreville Pond, Corinth	80
Oaklawn Lake, Corinth	40
Lake Park Lake, Corinth	80
Glovers Lake, Corinth	80
Booneville Fish Lake Company's Pond, Booneville	360
Bass Lakes, Centerville	7,000
Hamburg	3,000
Brandon	1,000
Valls Creek, Fayette	1,000
Spring Head Pond, Collins	1,000
Quiner Creek, Purnell	680
Valley Pond, Myrtle	116
Bass Pond, Hazelhurst	1,000
Evans Mill Pond, Shuqualak	40
Fish Lake, Holly Springs	80
Hoops Branch, Port Gibson	1,000
Sugar Knoll Lake, Corinth	800
Little Yellow Creek, Corinth	1,000
Hinkle Creek, Corinth	1,000
Mays Creek, Corinth	1,000
Cane Creek, Corinth	1,000
Bridge Creek Lake, Corinth	500
McCullars Lake, Corinth	500
Parmitchie Creek, Corinth	1,000
Meadors Fish Pond, Corinth	500
Sharp Fish Pond, Corinth	500
Adams Pond, Corinth	500
Lamberth Lake, Corinth	800
Waukomis Lake, Corinth	1,000
Clear Creek Trestle Lake, Corinth	500
Clear Lake, Corinth	800
Powells Lake, Corinth	800
Shady Lake, Guntown	500
Applicants	925
Missouri:	
Duck Lake, Shell City	75
Cutoff Lake, Brunswick	320
Spring Lake, Versailles	240
Boiling Spring, Billings	100
Moody Pond, Atlanta	120
Asylum Pond, Nevada	125
Shoal and Hickory creeks, Neosho	200
Katy Island Lake, Nevada	250
Fish Ponds, Nevada	250
Crescent Pond, Neosho	150
Hudsons Pond, Neosho	150
Willow Springs Pond, Willow Springs	900
Louisiana Purchase Exposition, St. Louis	17
Shady Brook Lake, St. Louis	120
New Hampshire:	
Dark Pond, Harrisville	400
Gilmore Pond, East Jaffrey	200
New Jersey:	
Millstone River, Princeton	150
Quicks Pond, Branchville	175
Delaware River, Belvidere	25
Piccatinny Lake, Piccatinny	400
Lake Shamong, Chatsworth	300
Mill Pond, Swedesboro	100
South Vineland	150
Blackwood Lake, Blackwood	150
Keans Pond, Woodbury	150
Olephants Pond, Harrisonville	150
Black bass—Continued	
New Jersey—Continued.	
Culvers Lake, Branchville	200
Silver Lake, Lucaston	200
Mountain Lake, Hoptacong	200
Lake Hoptacong, Hoptacong	800
Lake Grinnell, Sussex County	150
White Lake, Sussex County	150
Hutchinsons Pond, Trenton	400
Greenwood Lake, Cranford	2,100
New Mexico:	
Spring Creek Pond, Navarisa	50
Jaritos Reservoir, Springer	200
Castle Creek, Carlsbad	50
Tippecanoe Lake, Roswell	50
Reservoir, Roswell	50
Raton	200
Lake Stephana, Roswell	100
Lake Julia, Roswell	50
Cedar Lake, Tucumcare	50
Asylum Lake, Las Vegas	200
Fish Pond, Capitan	25
Roswell	50
New York:	
Lusk Reservoir, West Point	200
Fish Pond, South Salem	200
Bedford	200
Angola	150
Mill Pond, Hoosic	150
County Club's Pond, Eastport	200
Sills Pond, Greenport	100
Heaptauqua Lake, Chappaqua	100
Lake Aries, Troy	350
Susquehanna River, Binghamton	200
North Carolina:	
Fish Pond, Goldsboro	150
Manchester	50
Scotland Neck	200
Pine Bluff	75
Flatrock	1,000
Goldsboro	75
Moore Pond, Goldsboro	75
Mill Pond, Granite Falls	150
Greensboro	75
Havelock	75
Lucama	75
Maxton	75
Faison	50
Fish Lake, Lenoir	75
Pine Bluff	75
Spring Pond, Reidsville	50
Reedy Creek Pond, Browns Siding	75
Andersons Pond, Pinehall	50
Lake Jungle, Tunis	75
Haggarts Pond, Carthage	75
Cypress Pond, Castle	75
Long Pond, Castle	75
Holland Pond, Statesville	50
Southwest Creek, Kinston	75
Method Creek, Raleigh	50
Wyatts Mill Pond, Raleigh	200
Limestone Lake, Morrisville	50
Country Club Lake, Charlotte	75
Crystal Lake, Lakeview	200
Lucas Mill Pond, Highpoint	75
Trotters Mill Pond, Highpoint	75
Brown Pond, Marion	50
Goose Pond, Manchester	50
Earnhart Pond, Salisbury	50
Applicants	550
North Dakota:	
Lake Byrnes, St. John	200
Jervis Lake, St. John	300
Rose Lake, Rolla	200
Healms Lake, Hannah	150
Fish Pond, Dickinson	300
Johnsons Pond, Ellendale	100

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Ohio:	
Cuyahoga River, Mantua	145
Twin Lakes, Kemp	140
Chippewa Lake, Chippewa Lake	150
Fish Pond, Norwalk	120
Lake Pippin, Akron	150
Geauga Lake, Geauga	290
Little Beaver Creek, East Liverpool	150
Maumee River, Defiance	160
Spring Pond, Hillsboro	40
Big Miami River, Troy	150
Tyrnochtee Creek, Carey	120
Clear Fork, Mohican River, Belleville	120
Maumee River, Cecil	160
Napoleon	160
Auglaize River, Wapakoneta	150
Uniopolis	120
Eagle Creek, Phalanx	460
Olin Branch Pond, Cincinnati	120
Highview Park Pond, Reading	120
Lake Park Lake, Alliance	150
Applicants	320
Oklahoma:	
Fish Lakes, Walter	155
Spring Branch, Kremlin	75
Fish Ponds, Kremlin	75
Fish Pond, Oklahoma City	105
Ames	50
Mulhall	75
Glencoe	40
Woodward	100
Chilocco Lake, Chilocco	75
Spring Valley Creek, North Enid	120
Spring Valley Ponds, North Enid	75
Crutcho Creek, Oklahoma City	290
Blue Lake, Purcell	75
Peters Lake, Purcell	75
Humphreys Lake, El Reno	80
Yost Lake, Yost	205
Hopkins Dam, Chickasha	40
Beaver Dam Pond, Woodward	100
Cache and Medicine Creek, Lawton	300
Blue Beaver Creek, Lawton	138
West Cache Creek, Cache	120
Beech Spring, Glencoe	40
Boomer Creek, Stillwater	105
Coran Pond, Gage	50
Frogge Pond, Blackwell	75
Tecumseh Reservoir, Tecumseh	200
Maramec Pond, Avery	120
Newkirk Pond, Newkirk	240
Kingfisher Creek, Kingfisher	100
Spring Lake, Mangum	80
Applicants	460
Pennsylvania:	
Lake Cary, Lake Cary	200
Raystown Branch, Juniata River, Everett	300
Riddle Creek, Chester	150
Fish Pond, Butler	300
Manor	150
Elk Lake, Canton	200
Conneaut Lake, Cambridge Springs	200
Crystal Lake, Carbondale	350
Forest Lake, Montrose	200
Big Creek, Lehighton	600
French Creek, Franklin	400
Cochranton	100
Carlton	100
Utica	100
Allegheny River, Emlenton	300
Northeast Branch of Perkiomen River, Telford	300
Susquehanna River, South Danville	300
Black bass—Continued.	
Pennsylvania—Continued.	
Mill Pond, Washington	200
Plum Lake, Sandy Lake	100
Lost Creek Reservoir, Shenandoah	150
Conococheague Creek, Chambersburg	500
Elk Lake, Honesdale	300
French Creek, St. Peters	200
Conestoga Creek, Lancaster	200
Elk Lake, Montrose	150
Juniata River, Huntingdon	600
Stone Creek, Huntingdon	300
Standing Stone Creek, Huntingdon	300
Raystown Branch of Juniata River, Marklesburg	450
Lake Newangola, Nanticoke	450
Forest Lake, Bushkill	450
Frankstown Branch of Juniata River, Alexandria	150
Juniata River, Alexandria	300
Pickering Creek, Phœnixville	200
Eaglesmere Lake, Sonestown	300
Susquehanna River, Selinsgrove	300
Teedyuskung Lake, Rowland	200
Aughwick Creek, Mount Union	300
Lake Lewis, Eaglesmere	300
Juniata River, Altoona	300
Big Conestoga Creek, Leola	200
Allegheny River, Rockwood	300
Raystown Branch of Juniata River, Hopewell	300
Lehigh River, Freemansburg	300
Crooked Creek, McConnellstown	450
Naamand Creek, Boothwyn	150
Sugar Creek, Troy	300
Wiconisco Creek, Tower City	500
Moosic Lake, Scranton	200
Wissahickon Creek, Fort Washington	200
Schuylkill River, Pottstown	200
Mud Creek Lake, Frackville	350
Two Lick Creek, Indiana	300
Coxtown Lake, Starrucca	200
Island Pond, Starrucca	200
Starucca Pond, Starrucca	200
Conneaut Lake, Conneaut Lake	500
Susquehanna River, Susquehanna	300
Venango River, Meadville	400
Pottsville Lake, Frackville	150
Rhode Island:	
Watchaug Lake, Westerly	600
Yarker Pond, Kingston	200
Beach Pond, Providence	400
Nayette Pond, Providence	400
Sessons Pond, Newport	200
South Carolina:	
Fish Ponds, Greenville	1,000
Switzer	1,000
Eastover	500
Honeapath	800
Chappells	250
Fort Mill	1,000
Fountain Inn	2,000
Lancaster	2,250
Campobello	1,500
Bishopville	500
Middle Saluda River, Greenville	2,500
Bass Lake, Fort Mill	1,000
Fish Lake, Whitestone Springs	1,000
Tyger River, Woodruff	1,000
Enoree River, Clinton	1,000
Enoree	6,000
Green Swamp Pond, Sumter	500
Saluda River, Belton	5,000
Goose Creek, Otranto	500
Blackman Pond, Lancaster	1,000

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
South Carolina—Continued.	
Spring Branch, Trenton	1,000
Pelion	1,000
Mill Pond, Trenton	1,000
Greenwood Cotton Mill Pond, Easley	1,000
Saluda River, Honeapath	1,000
Little River, Honeapath	1,000
Beaver Dam Pond, McBee	1,000
Lake Como, Blaney	1,000
Caromaca Creek, Greenwood	1,000
Black River, Georgetown	500
Baker Creek, Pelzer	1,000
Manchester Pond, Rock Hill	1,000
Mill Pond, Tirzala	800
Smith Pond, Clover	800
Pressley Pond, Clover	800
Crowders Creek, Yorkville	1,000
Flat Creek, Kershaw	1,000
Lynchs River, Kershaw	1,000
Tuckahoe Lake, Kershaw	1,000
Gills Creek, Lancaster	1,800
Tributary of Gills Creek, Lancaster	800
Beaver Creek Pond, Lancaster	800
Warrior Creek, Enoree	1,000
Spring Branch, Yorkville	800
Messers Mill Pond, Columbia	1,000
Gray Spring Pond, Anderson	250
Greenwood Mill Pond, Greenwood	250
South Dakota:	
School Pond, Chamberlain	83
Enemy Swine Lake, Wambay	500
Lake Kampeska, Watertown	620
Pickerel Lake, Webster	450
Firesteel Creek, Mitchell	100
Vermilion River, Parker	100
James River, Parkston	100
Willow Creek, Bonesteel	116
Vermilion River, Vermilion	100
Fish Pond, Bendon	50
Ipswich	100
Amherst	150
Dakota River, Winthrop	33
James River, Alexandria	100
Ethan	100
Scotland	100
Menno	100
Lindebeck Lake, Woonsocket	66
Big Sioux River, Sioux Falls	66
Lake Campbell, Estelline	200
Lake Poinsett, Estelline	200
Lake Hendricks, Estelline	200
Bass Lake, Tyndall	33
Elderwood Lake, Ipswich	100
Jackson Lake, Ipswich	150
Wolf Creek Pond, Canova	66
Fish Lake, Glenn	34
Platte Pond, White Lake	34
Woonsocket Lake, Woonsocket	133
Nine Mile Lake, Brittan	450
Diamond Lake, Tyndall	33
Big Sioux River, Canton	66
Big Hoix River, Flandreau	66
Heatochwill Lake, Bendon	34
Fosness Pond, Presho	50
Tennessee:	
Big Creek, Del Rio	250
Little River, Rockford	150
Spring Creek, Chattanooga	75
Lake View, Chattanooga	75
North Chickamauga Creek, Chattanooga	100
Elk Fork Creek, Newcomb	75
Long Creek, Del Rio	350
Little Limestone Creek, Washington College	75
Flint River, Fayetteville	250
Black bass—Continued.	
Tennessee—Continued.	
Duck River, Manchester	100
Little River, Walland	100
Turnbull Creek, White Bluff	160
Fork of Shoal Creek, Lawrenceburg	194
Sweet Creek, Sweetwater	225
Fork Creek, Sweetwater	100
Pond Creek, Sweetwater	100
Estamaula Creek, Sweetwater	100
Fork of Duck River, Watrace	150
Loosahatchie Creek, Somerville	200
Gillens Pond, Donelson	80
Watauga and Doe rivers, Elizabethtown	200
Carp Lake, Trenton	40
Little Tennessee River, Lenoir City	150
Sweetwater Creek, Philadelphia	100
London	100
Clinch River, Harriman	150
Clinton	100
French Broad River, Leadville	75
Holston River, Strawberry Plains	100
Pistol Creek, Maryville	100
Ellijay Creek, Maryville	100
Beaver Creek, Powell	100
Emory River, Harriman	75
Tennessee River, Knoxville	225
Big Pigeon River, Newport	300
Clear Creek, Newport	75
Tennessee River, Louisville	100
Elk Fork Creek, Jellico	75
Clear Creek, Del Rio	150
Glen Cliff Lake, Lewisburg	100
Craigmiller Lake, Cleveland	75
Bigcreek Mill Pond, Rogersville	100
Arcadia Lake, Knoxville	100
Chickamauga Lake, Chattanooga	100
Fish Pond, Morristown	75
Elk Fork Creek, Elk Valley	75
Paunch Creek, Winfield	200
Garrison Creek, Wartrace	150
Lick Fork Creek, Elk Valley	100
Headwaters of Bull Run, Luttrell	100
Piney River, Goodrich	160
Fork of Red River, Cedar Hill	100
Applicants	320
Texas:	
Wolf Creek Dam, Shamrock	75
Fish Pond, Leroy	100
Sweetwater	300
Blooming Grove	150
Gatesville	300
Phelps	400
Jacksboro	200
Fayetteville	100
Roscoe	300
Anneta	300
Graham	150
Harrold	150
Santo	200
Sulphur Springs	300
Hillsboro	200
Baird	125
Flatonia	200
Waco	150
Austin	75
Brownwood	150
Commerce	100
Coleman	300
Burlington	125
Groesbeck	300
Gorman	125
Terrell	200
Bonham	300
Goliad	100

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Texas—Continued.	
Artificial Lake, Bryan	400
Taylors Bayou, Bluemont	500
Fish Lake, Sweetwater	200
Mertans	500
Jacksboro	100
Appleby	125
Chico	150
Coupland	300
Gainesville	75
Weatherford	200
Jacksonville	200
Luftin	1,000
Wichita Falls	200
Dallas	1,000
Buda	500
Dodds	300
Lott	200
Glosson	500
Albany	150
Rosebud	125
Cameron	200
Oakwoods	400
Hillsboro	200
Rock Wall	300
Buda	500
Turkey Creek, Cline	500
San Gabriel River, Liberty Hill	2,500
Hampton Pond, Graham	50
Spring Lake, Long View	100
Lakota Tank, Millsap	150
Park Lake, Jacksonville	300
Clear Lake, Weatherford	300
Jones Tank, Kemp	200
Water Tank, Kemp	200
Limbia Creek, Marfa	250
Phantom Lake, Marfa	250
Mill Pond, Chico	100
Tank Lake, Graham	250
Spring Pond, Alpine	75
Club Lake, Gainesville	325
Salt Creek, Texola	1,000
Running Spring, Langtry	150
Lake Covington, Rusk	100
Penitentiary Reservoir, Rusk	400
Harcrow Tank, Mart	300
Spring Creek, Plano	1,000
Cates Pond, Terrell	75
Artificial Lake, Midlothian	200
Benton Fish Pond, Richland	200
Little Clear Lake, Longview	100
Bailey Pond, Athens	100
Lake Falconer, Marlin	500
Key Brothers Lake, Lampasas	200
Yancy Creek, Lampasas	1,000
Lampasas River, Lampasas	1,000
Little Lucy Creek, Lampasas	1,000
Becker Pond, Kaufman	100
Lake Snow, Kaufman	400
Spring Branch, Plano	500
Lake Goodwin, Wills Point	500
Lake Thorne, Wills Point	950
Spring Park Lake, Palestine	400
Railroad Lake, Palestine	500
Perry Lake, Palestine	300
Saline Lake, Palestine	300
Dietz Lake, Palestine	500
Bachmans Lake, Dallas	2,750
Calloway Lake, Marshall	400
Lake Eloise, Waco	1,130
Standefer Pond, Waco	250
Days Spring Lake, Waco	1,000
Willow Lake, Waco	300
Louise Pond, Waco	100
Waterworks Reservoir, Waco	200
Palmetto Lake, Waco	200
Carters Lake, Alma	300
Ranch Pond, Ennis	300
Ball Pond, Dekalb	500
Black bass—Continued.	
Texas—Continued.	
Railroad Lake, Colorado	100
Bass Lake, Nacogdoches	1,000
Crystal Lake, Spring	200
Railroad Lake, Bryan	1,000
Elkhart	750
Phelps	750
Coleman Junction	650
Artificial Lake, Loneoak	200
Smithers Lake, Thompson	1,500
Round Lake, Jacksonville	300
Lake MacKenzie, San Antonio	1,000
Bermuda Pond, Sherman	125
Goon Lake, Gainesville	200
Fern Spring, Weatherford	150
Private Lake, Weatherford	200
Lake Jumbo, Weatherford	150
Clear Lake, Weatherford	200
Laundry Pond, Sherman	125
Lily Pond, Navasota	200
Fish Lakes, Albany	500
Bonham	200
Snalum Lake, Albany	300
Ackerman Lake, Albany	150
Gunter Lake, Gunter	2,500
Spring Lake, Uvalde	25
Three Fish Ponds, Hondo	600
Spring Branch, Catchspring	75
Jim Ned Creek, Coleman	500
Horne Creek, Coleman	500
Fayle Creek Pond, Albany	150
Big Tank, Albany	250
Tributaries of Red Deer Creek, Canadian	8,000
Cabin Creek, Canadian	2,900
Johnson Lake, Canadian	100
Fish Tanks, Roscoe	300
Vance Creek Pond, Lacoste	300
Hickory Lake, Roanoke	300
Pryor Lake, Uvalde	100
Baldwins Tank, Stamford	50
Red Creek Lake, Stamford	100
Hamilton Lake, Stamford	125
Post Lake, Stamford	75
Pond and lake, Alice	200
Diboll Lake, Diboll	1,000
Phillips Lake, Graham	400
Silver Lake, Alvord	200
Eden Lake, Moore	125
Lake Bernice, Cisco	600
Fish Ponds, Cisco	325
Corsicana	600
Kaufman	300
Albany	300
Stamford	275
Douglassville	350
Lake Thorndike, Longview	200
Lake Pauline, Longview	100
Mill Pond, Westville	300
Jamison Pond, Clarksville	200
Twin Lake, Jacksonville	100
McKnight Lake, Jacksonville	300
Fern Lake, Jacksonville	400
White Sulphur Springs, Troup	100
Bankhead Lake, Paris	300
Ellis Lake, Paris	150
Ragland Lake, Paris	150
Collins Lake, Paris	150
Country Club Pond, Paris	1,300
Willow Lake, Saron	300
Lake Park Lake, Hillsboro	400
Simpson Creek, Goldthwaite	500
Exall Lake, Dallas	1,250
Spring Branch, Pecos	500
Toyah Creek, Pecos	500
Shillers Lake, Elgin	500
Fin and Feather Club Lake, Honeygrove	300

Details of distribution—Continued.

Species and disposition.	Finger-lings, year-lings, and adults.
Black bass—Continued.	
Texas—Continued.	
Gallia Pond, Engle	150
Mitchell Lake, San Antonio	1,300
San Saba River, Goldthwaite	575
Sand Lake, Lewisville	300
Mill Pond, Mansfield	200
Holts Pond, Iatan	1,000
Irwin Lake, Cotulla	300
Harris Lake, Cotulla	400
Nueces River, Cotulla	850
Artificial Lake, Dodd City	75
Turney Pond, Smithville	200
Ginn Lake, Mountcalm	200
Morgans Branch, Athens	500
Camp Creek, Colorado	500
Comanche Creek, Pecos	1,000
Fish Club Lake, Hutchins	4,050
Holt Pond, Pittsburg	400
Artificial Lakes, Hubbard	500
Hill Tank, Hubbard	300
McDaniel Lake, Hubbard	300
Phillips Lake, Hubbard	300
Sanders Lake, Hubbard	300
Reformatory Lake, Gatesville	900
Oakes Pond, Perry	125
Boggy Creek, Shiner	1,000
Santa Fe and Clements lakes, Goldthwaite	800
Hickey Lake, Overton	400
Gourley Lake, Troup	400
Collier Lake, Troup	400
Gin Pond, Dekalb	150
Park Farm Lake, Beaumont	500
Alligator Lake, Edna	500
Allens Gin Pond, Minerva	125
Rio Grande River, El Paso	25
Trinity River, Fort Worth	450
Round Bale Pool, Greenville	150
Lake Sala, Talpa	400
Five Mile Creek, Flatonia	1,000
West Lake, Weatherford	300
Twin Creek, Maybank	200
Meadowbrook Lake, Sulphur Springs	400
Picnic Lake, Sulphur Springs	400
Thomas Pond, Sulphur Springs	300
Reynolds Pond, Kilgore	150
San Antonio River, San Antonio	1,500
San Pedro Park Lake, San Antonio	500
Fair Grounds Pond, San Antonio	205
Sullivan Lake, Flatonia	500
Artificial Lake, Otto	800
French Lake, Mineral Wells	200
Home Pond, Kemp	100
Greenbrier Lake, Burlingame	1,000
Johns Lake, Brownwood	500
Willes Creek, Brownwood	500
Fallon Lake, Sherman	250
Railroad Lake, Irene	40
Bellebrande	35
Railroad Pond, Saltillo	800
Fish Club Lake, Whitesboro	500
Lake Park, Temple	1,000
Cypress Creek, Comfort	1,000
Mill Pond, Brownsboro	200
Wood Lake, Denison	500
McCool Ponds, Whitesboro	150
Reservoir, Encinal	600
Randall Pond, Forney	250
Latimers Lake, Forney	150
Lake Myriad, Lufkin	500
Patterson Park Pond, Franklin	400
Walnut Lake, Higgins	500
Vintons Spring, El Paso	400
Durazuitas Creek, El Paso	1,000
Cana Pond, Mabank	150
Galloways Pond, Overton	200
Huffs Lake, Palestine	500
Shipps Lake, Smithville	600
Burns Pond, Kosse	400
Lake Aughtry, Booth	500
Johnson Lake, Longview	200
Old House Bayou, Booth	1,000
Fish Club Lake, McKinney	500
Fish Pool, Rosebud	100
Sycamore Park Pond, West	150
Buckham Lake, Whitesboro	450
Marshalls Mill Pond, Whitesboro	100
Tippitts Lake, Whitesboro	100
Blue Lake, Jacksonville	400
Lovelace Lake, Bonham	300
City Waterworks Pond, Bonham	300
Water Company Lake, Royce	150
Two small lakes, McKinney	500
Clear Lake, McKinney	300
Spring Creek, Skidmore	150
Ten large reservoirs, Alice	1,000
Pietzsch Pond, Lyons	100
Guadalupe River, Kerrville	1,000
Railroad Lake, Richland	600
Large Fish Pond, Ennis	500
Avoca Pond, Avoca	1,000
North Concho River, San Angelo	2,000
Lake Hay, Marshall	200
Large Lake, Fort Worth	500
Applicants	2,815
Virginia:	
Fish Pond, King William	100
Richmond	400
Drakes Branch	500
Crewe	1,500
Whitehall	500
Kinsale	400
Rawls Pond, Cansville	100
Mill Pond, Bacon Castle	100
Holly Springs Pond, Cotman	100
West Hampton Pond, Richmond	150
Watkins Mill Pond, Richmond	150
Greens Mill Pond, Richmond	150
Hermitage Pond, Richmond	500
Schwalms Pond, Richmond	400
Kings Mill Pond, Ashland	100
Rowles Pond, Ashland	200
Providence Forge Lake, Providence Forge	200
Edom Mill Lake, Harrisonburg	100
Boscobel Pond, Fredericksburg	100
South Fork of Shenandoah River, Waynesboro	1,100
Shenandoah River, Woodstock	100
Riverton	300
Modoc Lake, Norfolk	75
Staples Mill Pond, Lamberton	150
Joyce Lake, Norfolk	75
Broad Run, Bristow	200
Black Heath Pond, Midlothian	100
Mill Pond, Buffalo Junction	75
Big Calf Pasture River, Goshen	1,150
Mill Pond, Elmont	600
Cohoke Club Pond, Cohoke	800
Hilton Pond, Somerset	400
Rappahannock River, Warrenton	1,000
Little Borland Pond, Richmond	400
Rapidan River, Somerset	750
Robertson River, Somerset	750
Swift Creek, Ettricks	2,000
North River, Timber Ridge	1,200
Ice Pond, Ringgold	500
Sandy Creek, Danville	1,000
Griggs Pond, Whitehall	1,000
Occoquan Creek, Occoquan	1,000
Craigs and Johns creeks, Newcastle	1,150
North River, Lexington	1,000
Mabens Pond, Blackstone	800

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Black bass—Continued.	
Virginia—Continued.	
Jackson River, Hot Springs	1,150
Shirley Pond, Charles City County	1,200
Coventry Pond, Spottsylvania	400
James River, Gilmores Mills	1,200
Elmington Pond, Elmont	500
West Virginia:	
Tygarts Valley River, Valley Falls	1,300
Grafton	400
Cacapon River, Great Cacapon	300
Greenbrier River, Talcott	400
South Branch of Potomac River, Romney	600
Cheat River, Morgantown	300
Mill Creek, Ripley	150
Fish Pond, Jacksonburg	200
Big Wheeling Creek, Elm Grove	800
Big Sandy River, Naugatuck	500
Pattersons Creek, Keyser	200
Wisconsin:	
Bass Lake, Marinette	200
Pine River, Three Lakes	200
Elbow Lake, Athelstane	225
Total	488,490
Small-mouth black bass.	
Michigan:	
Brooks Lake, Newaygo	6,000
Whitefish Lake, Pierson	3,000
Park Lake, Bath	3,000
Tamarack Lake, Lakeview	3,000
Vermont:	
West River, South Londonderry	400
Eddy Pond, Rutland	200
Adsululu Pond, Ludlow	150
Echo Pond, Ludlow	150
Lamoille River, Cambridge	200
Groton Pond, Groton	200
Walcott Pond, Walcott	92
Total	16,392
Crappie.	
Arizona:	
Verde River, Jerome	250
Morgan Lake, Phoenix	200
Fish Pond, Fairbanks	100
Safford	100
Arkansas:	
Spring Pond, Rogers	100
Georgia:	
Silver Lake, Chamblee	50
Waldorps Pond, Jonesboro	50
Mill Pond, Jonesboro	50
Illinois:	
Fish Pond, Belleville	100
Crescent Mill Pond, Belleville	100
Scotts Lake, Belleville	100
Evergreen Pond, Belleville	400
Hillside Pond, Belleville	400
Bluffside Lake, East St. Louis	200
Fish Lake, Athens	1,200
Morgan Lake, Jacksonville	1,500
Meredosia Bay, Meredosia	1,400
Applicants	100
Indiana:	
Heaton Lake, Elkhart	700
Indian Territory:	
Fish Pond, Cherokee Nation	65
Iowa:	
Maquoketa River, Manchester	200
Kansas:	
Leas Pond, Kingman	75
Fish Lake, Kingman	100
Wallace Pond, Kingman	100
Crappie—Continued.	
Kansas—Continued.	
Bass Lake, Rago	100
Fish Pond, Sharon	100
Belmont	150
Medicine Lodge	75
Caney River, Grenola	150
City Water Ditch Lake, Medicine Lodge	900
Hopper Lake, Pratt	100
Saratoga Lake, Pratt	75
Macredie Creek, Clearwater	100
Gibsons Pond, Isabel	100
Rock Creek, Anthony	200
Silver Creek, Anthony	200
Applicants	100
Kentucky:	
Fish Pond, Hodginsville	250
Georgetown	200
Sparta	100
Lebanon	100
Versailles	100
Graves County	100
Mount Sterling	100
Wyndemere Pond, Simpsonville	90
Fair Ground Lake, Somerset	100
Lake Ellerslie, Lexington	500
Applicants	490
Maryland:	
Tinkers Creek, Prince George County	400
Abbie Lake, Hyattsville	300
Fish Pond, Washington Grove	75
Massachusetts:	
Sontag Lake, Lynnfield	200
Missouri:	
Duck Lake, Schell City	200
Fish Pond, Springfield	150
Marionville	100
Lake View, Springfield	150
Boiling Springs, Billings	50
Hill Crest Lake, Greenwood	150
Silver Creek, Joplin	100
Louisiana Purchase Exposition, St. Louis	44
New Jersey:	
Fairhaven Pond, Washington	200
New Mexico:	
Borenda River, Roswell	200
Artificial Pond, Roswell	100
Lake, Roswell	100
North Carolina:	
McLeon Pond, Maxton	300
Fish Pond, Franklinton	200
Pennsylvania:	
Mill Creek, Mansfield	200
Hill Creek, Mansfield	200
Schraders Pond, Mansfield	150
Buck Lake, Honesdale	300
Twelvemile Pond, Stroudsburg	200
Spring Pond, Norristown	200
Perkiomen River, Norristown	75
Sandy Run, Fort Washington	200
South Dakota:	
Lake Byron, Huron	160
Lake Wilcox	120
James River	160
Alexandria	160
Mitchell	160
Firesteel Creek	160
Lake Kampeska, Watertown	1,400
Pickerel Lake, Webster	100
Tennessee:	
Kimbrough Pond, Atoka	150
Bushbys Lake, Oakville	150
Loosahatchie Creek, Comerville	200
Reservoir, Knoxville	150
Mill Pond, Idaville	100
Piney River, Nunnelly	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Crappie—Continued.	
Texas:	
Fish Lake, Orphans Home	100
Fish Pond, Decatur	20
Waco	25
Midlothian	20
Mesquite	50
Queen City	44
Austin	20
Clearwater Lake, Vernon	30
Lakeview, Waco	80
Santa Fe Lake, Celeste	40
Hill Lake, Longview	50
Sloans Pool, Waco	30
Fish Lake, Longview	50
Live Oak Pond, Devine	20
Railroad Tank, Coleman Junction	50
Trinity River, Fort Worth	20
Fair Ground Pond, San Antonio	104
Applicants	210
Virginia:	
Tributary of Mud Branch, Hatton	100
Mill Pond, Warsaw	200
Woods Lake, Richmond	100
Minger Fish Pond, Richmond	200
Fish Pond, Broadrun	200
West Virginia:	
Fish Pond, Omps	200
Wisconsin:	
Lake Franklin, Three Lakes	175
Total	22,172
Strawberry bass.	
Indian Territory:	
Fish Pond, Vinita	150
Pennington River, Tishomingo	150
Bledsoe Lake, Choteau	100
Big Blue River, Ardmore	150
Reservoir, Byars	100
Louisiana:	
Lake Hayes	270
Lake Josephine, Shreveport	100
Harts Island Bayou, Shreveport	100
Alligator Bayou, East Point	100
Clear Lake, Coushatta	100
Missouri:	
Shoal and Hickory creeks, Neosho	200
Louisiana Purchase Exposition, St. Louis	34
Oklahoma:	
Cache Creek, Fort Sill	200
Avery Reservoir, Avery	150
Tecumseh Reservoir, Tecumseh	150
Newkirk Reservoir, Newkirk	250
Yost Reservoir, Yost	150
Texas:	
Fish Pond, Waco	50
Llewellyn Lake, Dallas	100
Fair Ground Pond, San Antonio	50
Total	2,654
Rock bass.	
Arizona:	
Verde River, Jerome	200
Arkansas:	
Fish Pond, Washington	300
Applicants	600
District of Columbia:	
Industrial Home Pond, Washington	200
Illinois:	
Fish Pond, Belleville	100
Columbia	100
Spring Pond, Belleville	100
Columbia	100

Species and disposition.	Fingerlings, yearlings, and adults.
Rock bass—Continued.	
Illinois—Continued.	
Gravel Pit, Effingham	100
Stillwater Pond, Alton	100
Sieferts Pond, Belleville	150
Burghardt Lake, Belleville	100
Lake and canal, Carbondale	100
Applicants	1,100
Indiana:	
Gravel Pit, Tipton	100
Walnut Pond, Gentryville	100
Reservoir, Osgood	100
Sunnyside Pond, Terre Haute	150
Fish Lake, Ferdinand	100
Pecan Valley Pond, Inglefield	200
Lily Pond, Inglefield	50
Fish Pond, Inglefield	150
Brazil	200
Hurricane Pond, Franklin	100
Gravel Pit, Summitville	100
Applicants	1,100
Indian Territory:	
Fish Pond, Muskogee	100
Iowa:	
Winters Pond, Mount Pleasant	200
Kansas:	
Fish Ponds, Pratt	400
Coffeyville	200
Cherryvale	150
Independence	200
Clearwater	200
Columbus	200
Mound Valley	200
Parsons	200
Liberal	400
Moline	200
Argonia	200
Sharon	200
Latham Lake, Latham	200
City Water Ditch Lake, Medicine Lodge	200
Talbott Lake, Medicine Lodge	300
Kentucky:	
Crumps Pond, Smith Grove	200
Fish Ponds, Greensburg	200
Versailles	400
Trenton	400
Crystal Lake, Pembroke	150
Three Ponds, Allensville	150
Fox Pond, Trenton	100
Rogers Pond, Shelbyville	100
Applicants	2,390
Louisiana:	
Applicants at Homer	70
Maryland:	
Fish Pond, Monkton	100
Deer Lake	150
Bartletts Run Pond, Barton	100
Fish Lake, Washington County	300
Hancock Lake, Hyattsville	200
Applicants	200
Massachusetts:	
Fish Pond, Whitinsville	200
Mississippi:	
Fish Pond, Meridian	200
Missouri:	
Katy Island Lake, Nevada	400
Cockes Pond, Sleeper	150
Elm Pond, Fordland	250
Eisley Pond, Noel	100
Fish Lake, Independence	200
Artificial Pond, Kirksville	100
Shoal and Hickory creeks, Neosho	200
Wallen Spring Pond, Cassville	100
Turley Pond, Desloge	200
Hulmes Lake, Independence	100
Steinmetz Pond, Glasgow	100
Atterberry Pond, Atlanta	200
Sac Creek, Bois D'Arc	200

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Rock bass—Continued.	
Missouri—Continued.	
Stukenbraker Pond, Bourbon	200
Hillnest Lake, Greenwood	500
Fish Pond, Rockville	200
Spring Pond, Butler	200
Railroad Reservoir, Lisle	3,100
Louisiana Purchase Exposition, St. Louis	30
Applicants	600
New Jersey:	
Panther Lake, Andover	100
Fish Pond, Dunellen	100
New Mexico:	
Castle Pond, Magdalena	100
Fish Ponds, Portales	850
Salt Lake, Roswell	250
Lake Elinor, Roswell	100
Lake Stephana, Roswell	200
Fish Pond, Deming	100
Applicants	300
New York:	
Fish Pond, Orchard Park	150
Mountain Pond, Garrison	100
Spring Creek, Poughkeepsie	100
North Carolina:	
Rock Creek Pond, Wilkesboro	100
Grove Pond, Castle	100
Kiger Pond, Winston-Salem	100
Ice Pond, Henderson	100
Fish Pond, Durham	100
Siloam	100
Hickory	100
Marion	300
North Dakota:	
Fish Pond, Oakes	100
Ohio:	
Eagle Creek, Phalanx	500
Liles Fish Pool, Bellecenter	150
Fish Pond, Proctorville	300
Maria Stein	100
Napoleon	75
Oklahoma:	
Fish Pond, Kremlin	150
Custer City	200
Alva	400
Okeen	200
Ames	300
Blackwell	400
Quay	150
Britton	150
Elgin	300
Miner Spring, Chandler	100
Spring Pond, Guthrie	100
Fish Lake, Arapahoe	200
Reservoir, Crescent	100
Okeen	200
Cottonwood Pond, Okarchee	100
Railroad Lake, Mountain Park	150
Artificial Lake, Stillwater	150
Applicants	850
Pennsylvania:	
Fish Pond, Mercersburg	100
Reading	200
Avonmore	100
Little Marsh Creek, McKnightstown	300
Tulpehoken Creek, Robesonia	300
Sycamore Pond, Penllyn	100
Mulligans Cove Run, Manns Choice	300
Sandy Run, Fort Washington	200
South Dakota:	
School Pond, Chamberlain	200
Shoe Creek, Huron	300
James River, Huron	200
Alexandria	200
Fish Lake, Ipswich	200
Fish Pond, Redfield	150
Applicants	700
Rock bass—Continued.	
Tennessee:	
Tellico River, Athens	200
Swan Pond, Cleveland	100
Fish Pond, Gambles	150
Leadvale	150
Little River	150
Knoxville	150
McCraw Pond, Braden	150
Emory River, Harriman	500
Burnett Lake, Del Rio	100
Laurel Creek, Del Rio	200
Sand Spring Pond, Ewells	100
Applicants	900
Texas:	
Fish Lake, Ladonia	50
Fish Ponds, Whitesboro	325
Forney	200
Sulphur Springs	125
Paris	50
Longview	200
Krum	75
Taylor	125
Lone Oak	100
Queen City	75
Lott	125
Lyons	175
Martin	225
Mexia	125
Odessa	150
Ranger	125
Gordon Lake, Paris	500
Dry Creek Lake, Taylor	125
Ranch Lake, Midland	140
Las Olmas Lake, Taylor	500
Artificial Lake, Terrell	75
Bermuda Pond, Sherman	50
Germany Lake, Grand Saline	50
Dans Pond, Grand Saline	55
Artificial Lake, Longview	120
Landry Lake, Sherman	75
Spring Lake, Uvalde	25
Brownwood Lake, Brownwood	100
Springhill Lake, Honey Grove	150
Knox Pond, Moran	200
Lovelace Pond, Bangs	75
Rio Grande River, El Paso	25
Trinity River, Fort Worth	240
Polecat Spring, Kyle	100
Fair Ground Pond, San Antonio	129
Shook Lake, Stamford	100
Powell Pond, Maybank	75
Sister Grove Pond, Farmersville	100
Fish Lake, De Leon	100
Reservoir, Artesia	125
Harrell Pond, Maybank	100
Onion Creek, Buda	200
Duraznite Creek, El Paso	170
Waterworks Reservoir, Waco	450
Lake Aughtry, Booth	300
Reservoir, Pearsall	75
Harkness Lake, Pearsall	50
Reeds Lake, Hillsboro	100
Lake Thorne, Wills Point	175
Applicants	1,980
Virginia:	
Mill Pond, Wittens Mills	100
Fish Pond, Rapidan	100
Hanover	150
Maidens	150
Stoney Creek Pond, Bedford City	250
Fish Ponds, Clayville	150
Taylors Pond, Purcellville	100
Willow Brook Pond, Newcastle	100
Dutch Creek, Elma	100
Leatherwood Pond, Axton	100
Martin Pond, Stuart	100
Small Lake, Esmont	150
Artificial Lake, Lee Hall	200
Slaty Branch Pond, Warminster	100

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Rock bass—Continued.	
Virginia—Continued.	
Back Creek, Roanoke	200
Applicants	775
West Virginia:	
Fish Pond, Charleston	200
Total	49,774
Warmouth Bass.	
Alabama:	
Fish Lake, Lincoln	100
Miners Mill Pond, Clanton	100
Florida:	
Cypress Lake, Cypress	200
Baker Lake, Umatilla	100
East Lake, Umatilla	100
Lake Lucerne, Orlando	100
Georgia:	
Spring Creek, Cairo	200
Fish Pond, Brunswick	100
Canton	100
Jasper	100
Hogansville	200
Outing Club Pond, Macon	200
Holly Springs Lake, Americus	200
Mill Pond, Jonesboro	100
Clarks Pond, Haddocks	100
Fish Ponds, Pendergrass	180
Mill Pond, Stephens Pottery	90
Holly Springs Lake, Americus	200
Louisiana:	
Klenaike Pond, Wilson	100
Mill Pond, Warnerton	100
Mississippi:	
Fish Ponds, Laurel	200
Clinton	300
Seminary	100
Hamburg	200
Crystal Springs	100
Forest	300
Fayette	450
Branard Pond, Hazlehurst	100
Artificial Lake, Gloucester	400
Dorsey Lake, Port Gibson	150
South Carolina:	
Bass Lake, Fort Mill	100
Fish Ponds, Fountain Inn	300
Woodruff	300
Greers	100
Switzer	100
Abbeville	100
Fair Forest	100
Spartanburg	100
Spring Branch, Westminster	100
Total	6,270
Bream.	
Alabama:	
Jordans Pond, Lapine	150
Fish Ponds, Fort Meigs	100
Opelika	150
Penrode	200
Dadeville	150
Pletcher	100
Ozark	150
Guin	100
Scotts Station	100
Penrode	350
Avery Lake, Opelika	350
Lakeview Lake, Opelika	150
Four Fish Ponds, Three Notch	600
Smith Little Creek, Selma	200
Spring Pond, Brantley	200
Giles Pond, Cuba	100
Spring Pond, Fort Deposit	150
Ingrams Mill Pond, Opelika	650
Colemans Pond, Union Springs	200
Cooks Pond, Fort Deposit	150

Species and disposition.	Fingerlings, yearlings, and adults.
Bream—Continued.	
Alabama—Continued.	
Willow Pond, Eufaula	150
Crenshaw Pond, Fort Deposit	150
Mill Pond, Dadeville	150
Blackwater Creek, Jasper	200
Cain Creek, Jasper	100
Clear Creek, Jasper	100
Lost Creek, Jasper	100
Lins Creek, Fitzpatrick	500
Williamson Pond, Hatchechubbee	150
Kemp Fish Pond, Georgiana	200
Sutton Pond, Andalusia	150
Randle Pond, Union Springs	200
Smith Pond, Hatchechubbee	200
Phillips Pond, Eutaw	100
Pea River, Elba	650
Georgia:	
Magnolia Lake, Atlanta	100
Brookwood Pond, Atlanta	100
Melrose Pond, Savannah	200
Lake Mohignac, Columbus	100
McCalls Mill Pond, Macon	50
Martins Pond, Temple	200
Greens Pond, Macon	250
Fish Ponds, Jasper	100
Warmsprings	60
Seville	200
Ellijay	500
Cusseta	500
Atlanta	300
Winder	500
Renfroe	150
Marietta	150
Jefferson	150
Clito	250
Lafayette	400
Box Springs	150
Greenville	550
Cairo	800
Greens Pond, Macon	250
Recreation Club Pond, Macon	250
Crumps Park Pond, Macon	200
Hooks Mill Pond, Americus	400
Chapmans Pond, Crawfords	200
Spring Pond, Marshallville	300
Curry Pond, Jefferson	500
Gime Pond, Butler	50
Ogeechee River, Crawfordsville	50
Byrds Fish Pond, Waverly Hall	500
Rich Pond, Summerville	300
Ridleys Pond, Lagrange	1,000
Mill Pond, Richland	500
Spring Pond, Cairo	200
Waterworks Pond, Columbus	800
East Lake, Dalton	150
Lake Juliette, Cedartown	200
Mill Pond, Cuthbert	500
Spring Pond, Weatherford	35
Bills Mill Pond, Cuthbert	150
Golden Camp Lake, Augusta	250
Clarks Pool, Emerson	150
Pearl Pond, Atlanta	150
Lakewood Lake, Atlanta	200
Tates Pond, Jasper	150
Beach Lake, Cuthbert	150
Ginn Pond, Hamilton	150
Walls Fish Pond, Dalton	150
Camps Pond, Dalton	150
Mill Pond, Meansville	200
Wilsons Fish Pond, Boneville	200
Chandlers Pond, Juniper	150
Harrisons Pond, Crawfordsville	200
Shuppa Pond, Columbus	200
Massus Creek, Rockledge	500
Rogers Pond, Coleman	300
Underwoods Pond, Atlanta	150
Illinois:	
Meredosia Bay, Meredosia	1,000

Details of distribution—Continued.

Species and disposition.	Fingerlings, yearlings, and adults.
Bream—Continued.	
Kentucky:	
Fish Pond, Crittenden	45
Shelbyville	80
Frankford	65
Bowers Pond, Lancaster	65
Little River, Hopkinsville	150
Lake Ellerslie, Lexington	65
Bagley Pond, Crittenden	45
Dowling Pond, Lawrenceburg	300
Mississippi:	
Haynes Mill Pond, Brooksville	50
Mooreville Pond, Corinth	150
Bynums Pond, Corinth	100
Holley Pond, Corinth	75
Morris Lake, Corinth	75
Morrison Mill Pond, Corinth	75
Morohams Lake, Corinth	150
Fish Pond, Corinth	75
North Carolina:	
Hintons Pond, Raleigh	200
Wyatts Mill Pond, Raleigh	800
Nolichucky River, Pigeon Roost	10,000
South Carolina:	
Spring Branch, Greers	100
Fish Pond, Gaffney	100
Spartanburg	100
Honeapath	100
Enoree River, Enoree	100
Goose Creek, Otranto	100
Spring Branch, Kershaw	200
Parkers Pond, Gaffney	100
Tennessee:	
Rich Pond, Tellico	500
Loosahatchie Creek, Somerville	150
Two Lakes, Cleveland	500
Indian Creek, Fishery	658
Texas:	
Fish Pond, Decatur	35
Paris	225
El Paso	350
Clearwater Lake, Vernon	75
Railroad Tank, Coleman Junction	25
Brownwood Lake, Brownwood	125
Fair Ground Pond, San Antonio	212
Fish Lake, Palestine	240
Railroad Lake, Irene	65
Belle Branch	60
Applicants	40
Total	39,920
Cod.	
Massachusetts:	*Fry.*
Atlantic Ocean, off Gloucester	35,376,000
Vineyard Sound, off—	
Tarpaulin Cove	24,076,000
Jobs Neck	4,363,000
Lackeys Bay	1,002,000
Woods Hole	587,000
Great Harbor, Woods Hole	12,353,000
Eel Pond, Woods Hole	322,000
Buzzards Bay, off Weepecket Islands	1,376,000
Total	79,455,000
Flatfish.	
Massachusetts:	*Fry.*
Great Harbor, Woods Hole	53,476,000
Vineyard Sound, Falmouth	35,723,000
Eel Pond, Woods Hole	926,000
Little Harbor, Woods Hole	2,097,000
Atlantic Ocean, Gloucester	124,615,000
Waquoit Bay, Waquoit	3,349,000
Buzzards Bay, off Weepecket Islands	8,086,000
Total	228,272,000

Species and disposition.	Fry.
Pollock.	
Massachusetts:	
Atlantic Ocean, Gloucester	1,246,000
Mackerel.	
Massachusetts:	
Great Harbor, Woods Hole	135,000
Vineyard Sound, Falmouth	189,000
Total	324,000
Lobster.	
Maine:	
Casco Bay, near—	
Diamond Island	2,700,000
Mackerel Island	1,500,000
Southside Back Bay	1,500,000
Clapboard Island	1,500,000
Cottage Cove	1,500,000
Husseys Sound	1,750,000
Cow Island	1,500,000
Broad Cove	1,500,000
House Island	1,500,000
Fore River	1,500,000
Gulf of Maine—	
Monhegan Harbor	1,500,000
Near Metinic Island	1,000,000
Muscle Ridge Channel	1,500,000
Near Stonington	500,000
Isle au Haut	500,000
Swan Island	1,000,000
Rockland Harbor	1,000,000
Wood Island Harbor	1,750,000
East side of Portland Head	1,750,000
Whitehead Cove	1,500,000
Between Boon Island and Cape Porpoise	6,000,000
Isle of Shoals	350,000
Between Monhegan and Georges Isle	3,150,000
Between Port Clyde and Whitehead	3,500,000
West side of Long Island	1,500,000
Near Ship Cove	1,500,000
Off Boon Island	500,000
Cape Porpoise Harbor	2,000,000
Off mouth of Kennebec River	500,000
Atlantic Ocean, off—	
Whaleback Light	4,500,000
York Ledge	1,500,000
Silas Point	1,500,000
Stones Ledge	1,500,000
Coast of Maine—	
Frenchmans Bay	1,000,000
Quoddy Bay	500,000
Lubec Narrows	500,000
Moosabec Reach	1,000,000
Off Prospect Harbor	1,000,000
Near Ponds Island	1,000,000
Near Averys Rock Light	1,000,000
Massachusetts:	
Atlantic Ocean—	
Gloucester	22,350,000
Manchester	3,450,000
Rockport	3,650,000
Marblehead	1,400,000
Beverly	1,100,000
Lanesville	800,000
Vineyard Sound, Falmouth	2,088,000
Great Harbor, Woods Hole	1,979,000
Buzzards Bay—	
Falmouth	5,033,000
Gosnold	367,000
Hadley Harbor, Gosnold	215,000
Ipswich Bay, Newburyport	500,000
New Hampshire:	
Atlantic Ocean, near Ordians Point	1,500,000
Total	106,882,000

REPORT ON INQUIRY RESPECTING FOOD-FISHES AND THE FISHING GROUNDS.

By Barton W. Evermann, *Assistant in Charge.*

OUTLINE OF THE WORK.

A large part of the work of this division during the fiscal year 1904 consisted in the continuation of investigations already begun with reference to the biology and culture of various animals of economic importance, including principally the oyster, the commercial sponges, the blue crab, and the diamond-back terrapin; studies of the fresh-water fishes of Maine and of the biology of the small lakes of northern Indiana were also continued. Several new inquiries were instituted, those of especial importance being an investigation of the Alaska salmon fisheries, a biological survey of the coast of California in the vicinity of San Diego and in Monterey Bay, and experiments in the culture of the green turtle. Various fresh-water lakes in western Washington and the waters of the Gila River basin in Arizona were examined with reference to their physical characteristics and the possibilities of fish culture. The investigations dealing with the diseases of fishes were pursued with reference to a number of special phases, as well as those already studied.

THE OYSTER.

Experiments in oyster fattening at Lynnhaven, Va.—For a number of years, as may be seen by reference to preceding reports, the Bureau has been engaged in an endeavor to develop a practical method of fattening oysters. It is the custom of many growers to transplant their oysters, shortly before putting them on the market, to beds where the natural supply of food is luxuriant and oysters rapidly fatten. In many localities such favorable places are few or entirely lacking, and the oysterman is compelled to put inferior stock upon the market and thus forfeit the full measure of profit.

The experiments which have been carried on by the Bureau under the direction of Dr. H. F. Moore and in the immediate charge of Col. W. W. Blackford, of Lynnhaven, Va., are intended to develop

a method of artificially producing these fattening beds in localities where they do not naturally exist.

A bight of Lynnhaven Bay, embracing a water area of 2.6 acres and an average depth of about 2 feet, has been cut off from the open waters of the bay by a dam, excluding all but the highest storm tides.

The food of the oyster consists mainly of microscopic plants, of much beauty of form and color and remarkable motility, known as diatoms. These, like the higher plants, are dependent for their growth or multiplication upon the supply of inorganic salts in the water. Ordinarily this is obtained by the natural drainage from the land, and consequently oyster food is generally more abundant in the neighborhood of the mouths of streams having rich and extensive drainage basins. Warmth during at least a part of the year is also an important factor in the multiplication of diatoms, and consequently shallow waters, rather than deep ones, are usually better for fattening beds, other conditions being equal. Under the system in vogue in France shallow ponds apparently of themselves satisfy the conditions, but this was not the case at Lynnhaven. There was evidently a dearth of useful saline constituents in the water, and to supply this commercial fertilizers were introduced. The result was prompt, and there was an almost immediate increase of diatomaceous growth in the pond.

This abundance of food having been secured, oysters were placed in various parts of the pond, but the results were mainly negative, and a study of the conditions indicated that this, in a measure at least, was due to the absence of currents to waft the food within reach of the sessile oysters. In the following year a remedy was found. At one side of the pond, or claire, a canal 150 feet long and about 8 feet wide was constructed of sheet piling. A circulation of water through this canal, and returning via the open waters of the pond, was secured by the use of a propeller operated by means of a gas engine, thus simulating the conditions supplied on the natural beds by tidal movements. The result of this arrangement was very satisfactory, and oysters placed in the canal were fattened, in some cases within a period of eight days, much improving their value on the market.

New difficulties were encountered, however, and to the present time these have not been removed. There developed at times in the fattened oysters a decidedly marshy taste, which was eventually traced to an abundant growth of filamentous algæ in certain portions of the claire. The same saline richness of the water which proved so favorable for the diatoms was equally favorable to the growth of other vegetable matter. It was found that a limited application of lime water retarded or destroyed the algal growth, but it was necessary to exercise constant watchfulness and frequently the affection would develop suddenly and stop the shipment of oysters at a time when they were bringing the best prices. During the present year it was

found, too, that there was some danger in the application of lime, a variation in the methods previously used having resulted in the destruction of a large proportion of the diatoms. At the close of the fiscal year, experiments were being conducted with extremely attenuated solutions of copper sulphate, after the method of water purification developed and recommended by the Department of Agriculture.

A second difficulty was the gradual freshening of the water in the claire during periods of excessive rainfall. To overcome this, a propeller pump was installed to maintain constant fullness of the pond by pumping water from the bay to replace that lost by evaporation, the pump being driven by the same engine which operated the propeller for maintaining currents. The results were entirely satisfactory.

In general it may be stated that the feasibility of fattening oysters by this method has been amply demonstrated, but owing to the many unforseen difficulties and delays encountered, it has not been possible to operate the claire at its full capacity, and the commercial possibilities of the system have not yet been developed.

Experiments on the North Carolina coast.—The experiments and investigations in oyster planting and oyster culture begun on the North Carolina coast in 1902, in collaboration with the geological and natural history survey of North Carolina, have been continued by the Bureau through the Beaufort laboratory. The work has been conducted in Pamlico Sound and Newport and North rivers, but in the past fiscal year was confined to Pamlico Sound.

The object of these experiments is primarily to ascertain to what extent and with what profit the great areas in this region now barren of oysters may be made productive, whether the absence of oysters in a special region is due to other causes than the lack of cultch, and what method of planting is best suited to the particular combination of conditions (bottom, depth, abundance of spat, salinity, food, etc.) prevailing in a particular locality.

Private planting seems to be on the increase; while yet very limited, it is apparently more common and more profitable than it was a few years ago. In at least one region (Portsmouth) such planting has already proved to be cramped by the scarcity of "seed." Large areas convenient to such places, but not adapted to yield a market product, might be utilized by private persons or by the state for growing seed oysters. It is also to be determined whether the present natural beds may be artificially enlarged.

Thirty plants were made during 1904, there being now a total of 35 plants in 13 localities. Some of these plants have been made not with the immediate object of creating small oyster rocks, but to answer certain definite questions; for instance, before making extensive plants in doubtful places it is advisable to ascertain whether spat will catch in such an area, and to what extent sanding up or sinking in the mud

may be expected to occur. A small ridge or mound may in some cases be a satisfactory preliminary plant. If there is an area in Pamlico Sound where a set will not occur it will be encouraging to know this. On the other hand, if an area should be found where spat will not set, a rare opportunity will thus be discovered for interesting experiments to throw light on important open questions concerning the distance of setting place from birthplace of an oyster, and the value of placing a few spawning oysters in a bed.

EXPERIMENTS IN SPONGE CULTURE.

The experiments in sponge culture which this Bureau has been conducting for several years, and references to which have been made in previous reports, have been continued during the present year under the direction of Dr. H. F. Moore. The general methods followed have not diverged materially from those employed during the past two years. The sponges are cut into pieces about 1 inch square and 2 inches long, with a slit about 1 inch deep in a plane parallel to one of the long sides of the cutting. The slit is placed astride of the wire or line used for a support, and the two faces are bound closely together, with the result that they eventually fuse into an organic whole surrounding and closely embracing the line.

The experiments of the present year have been directed mainly to testing various materials for the supporting wires, which are festooned between stakes planted in the bottom about 25 to 30 feet apart, with the cuttings distributed along them at intervals of about 1 foot. The experience of the preceding fiscal year demonstrated that though the organic adhesion of the young sponge to its support was not essential, it was of very material advantage. When organic attachment does not take place, there is always the liability that the sponges will become loose, owing to the corrosion or loosening of the short lengths of wires by which they are secured to the main supporting wires. When this takes place, it necessitates refastening, otherwise the sponge rotates under the action of the waves, becomes abraded at its point of attachment, and if inverted undergoes the necessity of an entire readjustment of its circulatory canal system. An inverted sponge tends to reverse the direction of the internal water currents by which it feeds, breathes, and excretes, the original oscula, or openings for the escape of the water, closing up and new ones being formed on the new upper surface. While this is going on, the sponge is apparently at a disadvantage in the performance of its functions, and there is a retardation of growth.

Any arrangement, then, which will obviate the expense of refastening and insure the maintenance of the cutting's original orientation with respect to its support and to the horizontal, is a distinct advantage. Previous experience had shown that lead possessed this property, but

that lead wire is too weak to support even its own weight in the lengths necessitated by the conditions of the experiment, and in the preceding fiscal year the expedient was tried of using ordinary tarred marline with a thin casing of lead. The marline supplies the required tensile strength, and the lead, besides serving as a protecting covering for the cordage, furnishes the desired surface for the attachment of the sponges. The cuttings within a week attach themselves to the lead and soon form an adhesion sufficiently close to prevent oscillation in the waves and yet not so close as to offer an impediment to their removal from the wire when it is desired to harvest them. Lead-covered marline had been in use for twenty months at the close of the fiscal year, and yet showed no indications of impairment in strength. It must last twice that long, however, to demonstrate its usefulness.

When leaded marline was first employed the lines were rigidly attached to the stakes, but the continual swaying in the waves caused repeated flexure near the point of attachment, and resulted in fracturing the inductile lead and abrading the marline core to the breaking point. A flexible attachment is now employed, and there is no longer this difficulty.

Asbestos cord, treated with a mixture of paraffin and asphaltum and incased in lead, and lead-covered underwriters' wire have also been tried, with results in general similar to those above described.

With the use of lead it became necessary to abandon aluminum wire for attaching the sponges and closing the slit, as electrolytic action destroyed it before it could serve its purpose. Rubber bands are now employed instead, care being exercised to have them of such length, compared to the size of the cutting, that no undue pressure is exerted on the tissues of the sponge.

The growth of the sponges during the year has been satisfactory, some of them having attained a size of over 5 inches at the age of thirty months. Others, eighteen months old, are 4 to 4½ inches in diameter. At Anclote Key there has been a somewhat alarming mortality among the larger ones, and this may indicate the beginning of serious difficulties, as there is a possibility that these sponges may be approaching their limit of growth, if such exists. At Sugar Loaf Key and in Biscayne Bay, where the growth has been slower, this difficulty has not developed. During the next fiscal year, this matter will receive special attention, as the experiments are now approaching a critical stage. No apprehension is felt that insuperable difficulties will be encountered.

THE BLUE CRAB.

The investigations and study of the life history of the blue crab in Chesapeake Bay begun by Prof. W. P. Hay in 1902 have been continued by him during the past fiscal year when opportunity offered. Many important observations were made at Crisfield, Md., and at

other places. The results of these investigations have been set forth by Professor Hay in a special report to be issued by this Bureau.

THE DIAMOND-BACK TERRAPIN.

During the summer of 1903 Professor Hay also continued his studies of the terrapin of Chesapeake Bay, these investigations having been undertaken for the purpose of determining what, if anything, might be done to preserve this important fishery. Recent observations of the terrapin market indicated a serious decrease in the size and number of these animals sold and an increasing difficulty on the part of the dealers in securing terrapin of commercial size. The native Chesapeake Bay terrapin had become alarmingly scarce and the firms engaged in the business were securing much of their stock from the Carolinas and southward.

The experiments carried on by Professor Hay were directed chiefly toward a study of the life history of the terrapin and the discovery of proper methods of caring for them while confined in pounds or other artificial inclosures. Little difficulty is experienced in retaining them in inclosures or in feeding them, but conditions under which they will breed freely while in such inclosures have not yet been found, and difficulty has been experienced in providing proper conditions for the development of the few eggs that are produced. Another difficulty has been to retain the young hatched in the pounds; while yet very small they frequently disappear and can not be found. The obstacles to success, however, do not seem insurmountable, and it is believed that a satisfactory method of terrapin culture will soon be developed.

In early September the operations were transferred to Crisfield, where, at the pound belonging to Messrs. Tawes & Riggin, there was an opportunity to study a number of species of diamond-back terrapin and their behavior in captivity. It was ascertained that four well-marked species and one subspecies of the genus *Malaclemmys* are now being sold for food, and that all of these can be profitably impounded in Chesapeake waters. As the entire lot of terrapin marked during the summer of 1902 was found to have lost the tags, another effort was made toward ascertaining the rate of growth by tagging over 100 individuals and releasing them in this pound. Early in the spring of 1904 the Bureau decided to establish a small experimental pound of its own, and for this purpose selected a spot on the Choptank River near Lloyds, Md. Six pens, about 20 by 40 feet, were built and stocked with the best Chesapeake terrapin. An abundance of flowing water and food is assured, and there are sand beds and sunning banks extensive enough for every purpose. It is hoped that by the end of another season definite information will have been obtained regarding the possibility of artificially propagating these vanishing animals.

THE GREEN TURTLE.

A comparatively few years ago green turtles were abundant on the coast of Florida, and their capture gave employment for a part of the year to a considerable number of fishermen. They were shipped to the northern markets in considerable numbers, and their flesh and eggs were common articles of diet on both the east and west coasts of the State. So persistently were they sought, however, and so recklessly were their nests on the beaches robbed of the eggs, that the species is now seen but rarely, and the fishery has ceased to exist. The green turtles now put on the markets come mainly from the coast of Mexico and Central America, and the price has risen until turtle meat is regarded as more or less of a luxury, even in places where it was formerly abundant. The demand for small turtles has always been greater than the supply, and they command a proportionately higher price than the larger sizes. The market for them could be greatly enlarged if it were possible to procure them, and it is the opinion of the Bureau that this demand may be met by employing some method of turtle culture. Toward the end of the fiscal year experiments were begun, under the direction of Dr. H. F. Moore, with a view to developing a practical method of raising turtles from the egg. A considerable number of eggs have been obtained, and are now undergoing incubation. When hatched the young will be placed in a suitable inclosure and experiments will be made to determine the most suitable food and the best manner of rearing them. Later an attempt will be made to breed the turtles in captivity.

ALASKA SALMON INVESTIGATIONS.

At the close of the preceding fiscal year, as stated in the last annual report of the Bureau, a special commission had been appointed by order of the President to study and report upon the condition and needs of the Alaska salmon fisheries, and, under the direction of Dr. David S. Jordan, of Stanford University, had reached southeast Alaska and was just entering upon its duties in July, 1903. Shore parties were established at Loring, in southeast Alaska, at Karluk, on Kadiak Island, and at Nushagak, in the Bristol Bay region, these being considered three of the most important fishing centers and affording opportunity for investigation, throughout the season, of the local conditions and the fisheries there carried on. The habits of the various species of salmon and the problems of their culture in those regions were also studied. Practically all of the salmon canneries, salteries, and fisheries in southeast Alaska, also those at Yakutat Bay, Kadiak Island, Chignik Bay, and Bristol Bay were visited by the commission, and their methods investigated. Interviews and conferences, also, were held with the officials of many of the canning companies, and with various persons interested in the different phases of

the salmon industry, to the end that a clearer understanding of the problems involved might be obtained.

Incidental to the salmon investigations numerous dredgings were made by the steamer *Albatross* at various depths in the straits and fiords of southeast Alaska and about Kadiak Island, Afognak Island, and Yakutat. These investigations had in view the development of the aquatic fauna of Alaska, and resulted in large and interesting collections, not only of fishes, but of mollusks, crustaceans, and other invertebrates. These collections have been assigned to specialists for study and report.

The salmons of the Pacific.—The salmons of the Pacific differ notably, as a whole, from the single species called salmon (*Salmo salar*) on the coasts of the North Atlantic. Anatomically they differ in several details of structure; in habits the distinctions are still more marked. Normally, the Atlantic salmon survives the reproductive act and returns to the rivers at the spawning time for several years. The Pacific salmons, on the other hand, have more definite runs. The greater part of their lives is spent in the sea, and they run into fresh water only at spawning time. During this period they take no food of any kind, the oil of the body is consumed, the flesh becomes dry and pale, the jaws of the males become much elongated and distorted, the front teeth are enlarged, the color is changed, and the whole body becomes greatly distorted. Death follows within a few days after spawning. There is no evidence that any individual of any species of Pacific salmon ever survives the reproductive act.

All the Pacific salmons spawn on a falling temperature, when the water is already cool and becoming colder. Freezing kills the eggs, but any temperature between 54° F. and freezing is favorable to their development; above the former point the eggs develop precociously and the young fish are apt to die. In the more northern rivers a temperature of 54° is reached earlier, and for this reason the run of salmon occurs earlier in those regions than in the southern waters of Alaska. All the species spawn by preference in running water, though occasionally some individuals spawn in lakes. The spawning beds are usually on gravel bars, and in the spawning act the gravel is pushed about, not for the purpose of covering the eggs, but rather as a part of the spawning act itself; pressure against the gravel aids in the extrusion of the eggs. The male covers the eggs with milt, and in so doing also moves the gravel about to some extent. This fact is a matter of importance where different species, or different schools of the same species, spawn upon the same beds, the later comers disturbing more or less seriously the eggs of those which have preceded them.

There are five species of salmon in Alaska and neighboring waters, and they are identical with the species found on the coasts of British Columbia, Washington, Oregon, and California. These five species

are well defined, and differ widely in habit and in commercial value, a matter of vital importance to an understanding of the salmon question.

(1) The chinook salmon, *Oncorhynchus tschawytscha* (Walbaum), is called king salmon or spring salmon in Alaska; spring or chinook salmon on Fraser River and Puget Sound; chinook, quinnat, or Columbia River salmon on the Columbia; and Sacramento River salmon in California. It is called tyee salmon where the Chinook jargon is spoken, and *tchavitche* among the Russians. It reaches a larger size than any other species, the average weight of those caught in the com mercial fisheries being about 22 pounds, while examples weighing 40 to 60 pounds are not rare, and occasionally individuals have been taken which had reached the enormous weight of 80 to 100 pounds.

In quality of flesh the chinook salmon is superior to any other. Its flesh is red, rich, tender, and deliciously flavored, becoming paler in color, however, and less rich in flavor as the spawning season approaches. This salmon may readily be distinguished by its large size, the presence of round, black spots on back and tail, 15 to 19 branchiostegals, and 18 or 19 rays in the anal fin. As the breeding season approaches, the colors become duller and the sides blotched with dull red.

The chinook salmon runs in the large rivers, especially those having glacial or snow-fed tributaries. Its chief run is in May and June in the north, in June, July, and later in the Columbia, and still later in the Sacramento. In the Columbia and Sacramento there is a more or less distinct run in September. In northern Alaska the principal run is in May; in Bristol Bay, about the middle of June. This salmon goes to the very headwaters of the streams it inhabits, in the Columbia reaching the Sawtooth Mountains in central Idaho, and the headwaters of other streams furnishing suitable spawning grounds. In the Yukon some individuals are said each year to ascend to Caribou Crossing on Lake Bennett, a distance of 2,250 miles from the sea.

In Alaska, the fish runs in appreciable numbers in the Stikine, Taku, Chilkat, Alsek, Kussilof, Copper, Knik, Nushagak, Yukon, and Kowak rivers. It is not abundant in southeast Alaska, though small schools are sometimes seen in pursuit of schools of herring, and occasional individuals may be taken any month in the year at certain places, particularly in Chatham Strait. It is not believed that the species goes far out to sea, or for any great distance from the mouth of the stream in which it was spawned.

(2) The red salmon, or red-fish of Alaska, *Oncorhynchus nerka* (Walbaum), is known in the Columbia River as blueback salmon, and on the Fraser River and in Puget Sound as the sockeye, a Chinook word originally spelled *sukkegh*. By the Russians it is called *krasnaya ryba*, which means redfish.

This species is the neatest in form and most symmetrical of the salmons. Its usual weight at maturity is about 7 pounds, the range being from 3 to 10 or 11 pounds. The largest example seen in Alaska during these investigations was taken in Chignik Bay, and weighed 10 pounds 8.5 ounces. The flesh of this salmon is deep red and of good quality, though much less juicy than that of the Chinook; it is firmer than that of any other salmon, and lends itself readily to canning processes. In the sea the fish is clear sky blue on the upper part of its body, silvery below, and without spots. After entering the rivers to spawn, the color changes to crimson, at first very bright, but soon becoming darker blood red and more or less blotched. The head, in marked contrast with the body, becomes a bright olive-green in color. In the males the back becomes somewhat humped and the jaws become extravagantly produced and hooked.

In Alaska this species runs chiefly in July. It is said to run long distances up the Yukon and to the headwaters of the Columbia in the Sawtooth Mountains. It almost invariably spawns in small streams tributary to lakes, occasionally in the lakes themselves about the mouths of the tributary streams. It rarely, if ever, runs in any stream which has not somewhere in its course a lake with available spawning grounds in the stream or streams at its head. These streams are often very small, perhaps only a few feet across and a few inches deep, but the salmon may enter them in great numbers. The determining factor is always the presence of a lake with suitable spawning beds above it, whether the lake be only a few rods from the sea, as at Boca de Quadra, or many hundreds of miles, as in the case of the Columbia.

With the red salmon and the chinook of the usual size there are often found much smaller individuals. Among the red salmon these seem most abundant at Chignik Bay, where they are called "Arctic salmon." The small red salmon of Necker Bay, Baranof Island, are probably of the same nature.

(3) The silver salmon, *Oncorhynchus kisutch* (Walbaum), is called silversides or silver salmon in the Columbia, coho on Puget Sound and the Fraser River, and coho or silver salmon in Alaska. To the Russians it is known as the *kisutch* or *bielaya ryba*, which means white fish. The flesh of this species is less firm than that of the red salmon, and is rather pale, not possessing the deep-red hue of the latter; also, the scales fall off more readily when the fish is handled. In flavor the flesh is distinctly better, and only the pale color keeps it from ranking with the best of salmon. The silver salmon ascends the streams for short distances only, and when in salt water it seems to remain close inshore. The young can be taken with a seine along the shores in Alaska at almost any time, and seem to remain in the rivers longer than the young of the other species. The run occurs in

the fall, and does not usually begin before the middle of August, continuing until late in September. In southeast Alaska the species is quite abundant and is increasing in importance each year. Usually the canneries pay the fishermen the same price for this that they pay for the red salmon. It is canned as "Coho," or "medium-red" salmon.

(4) The humpback salmon, *Oncorhynchus gorbuscha* (Walbaum), is known to the Russians as *gorbuscha*, and to the trade as pink salmon. It is the smallest of the five species of Pacific salmons, seldom weighing more than 6 pounds, and usually not exceeding 3. It may be readily distinguished by its very small scales, and the presence of oblong black spots on the tail. The flesh is very much less firm than that of the preceding species, is pale in color, and the characteristic salmon flavor is less pronounced. When fresh and directly from the sea it is very palatable and wholesome, and is generally regarded, next to the chinook, as the best of all the salmon when fresh. As a salted fish it also ranks well, and salted humpback bellies are esteemed a great delicacy. It does not keep well in a fresh state, however, the flesh becoming soft very soon after taken out of water, and becoming tainted in forty-eight hours or less, even in the cool climate of Alaska. By the time the fish has reached the rivers on its way to the spawning grounds, its flesh has lost the little oil that it had, and is almost worthless as food. Only when caught some time before it would have entered the streams is it fit for canning purposes.

The humpback salmon carries the changes due to the spawning period to an extravagant degree, the distortion of the jaws and the development of the hump on the back being excessive and giving the fish a remarkable appearance. It is the most abundant salmon among the Alaskan islands, existing in millions, and swarming everywhere along the shores and in waters near the sea, in streams, brooks, lakes, swamps, and brackish estuaries—in fact, in all places where a little fresh water can be found. It does not ordinarily go far from shore, and does not run up the stream for great distances. It does not frequent the larger rivers, and is therefore almost unknown in the Sacramento and Columbia, and even in the Fraser; but most of the smaller rivers in Alaska are crowded with humpbacks. On account of its great abundance and the ease with which the fish is taken in nets of any sort, it is exceedingly cheap in Alaska, the price paid the fishermen by the canneries being only $7.50 to $10 per thousand fish.

Not until a few years ago was there much demand for the humpback for canning purposes, but as the canning establishments are finding it more and more difficult to fill their guarantee pack with red salmon, the demand for the humpback has increased correspondingly. The species is so abundant that there has never been the least difficulty in supplying the demand.

(5) The dog salmon, *Oncorhynchus keta* (Walbaum), is known also as calico salmon, and, by the Russians, as *hayko;* in Japan, where it is especially abundant, it is called *saké;* to the trade it is known as chum. Next to the chinook, the dog salmon is the largest of the five species, reaching a weight of 16 pounds. The average of many examples weighed at Kell Bay was 8.28 pounds. It is a plump, silvery fish when fresh from the sea, and at that time closely resembles the silver salmon. Later the dark of the back tends to form vertical bars on the sides, and in the breeding season the body becomes largely dirty black, obscurely barred with dirty red, and the jaws become greatly elongated and distorted. The species enters all sorts of rivers and small streams late in the fall, but does not ascend them to any great distance from the sea. It is very abundant in southeast Alaska, and can be taken in almost any stream from the Columbia to the rivers of northern Japan.

The flesh of the dog salmon is very pale, with little of the salmon flavor and none of its color. When fresh in the spring and early summer, it is well flavored and wholesome, but when canned it is dirty white, soft and mushy, and with a strong muddy taste. As the spawning time approaches the flesh becomes still more pale and mushy. It is then wholly unfit for canning and there is little market for it.

This salmon takes salt well. In Japan, where it is the largest and most abundant salmon, great quantities are salted, and it is in Japan that a market is found for the considerable quantities salted in Alaska. When taken in the spring, frozen fresh, and sent in cold storage to the East and to Germany, it sells readily.

The relative food values of the five different species of Pacific salmon when canned may be roughly expressed by the five digits, thus: chinook, 5; red salmon, 4; coho, 3; humpback, 2, and dog salmon, 1. The coho might be placed at 3.5, or even a little closer to the red. The canned product has at the present time approximately these relative values, but the aggregate value of the red salmon now exceeds that of the chinook.

Besides the five species of salmon, five species of trout are found in Alaska. These are the steelhead, Dolly Varden, cutthroat, rainbow, and Great Lakes trout.

Commercially, the steelhead (*Salmo gairdneri*) is the most important of the trouts, but it is not abundant anywhere, though frequently taken in southeast Alaska about the mouths of the larger streams, which it enters for the purpose of spawning. It is a fine large fish, reaching a weight of 10 to 35 pounds, and may be distinguished from any species of salmon by its smaller anal fin, its numerous black spots, and its short head. As a fresh fish it is excellent for food, and when frozen finds a ready market in the East. It is sometimes salted, but is not much used for canning in Alaska, chiefly because it is not obtainable in large

quantities. It has been canned to some extent on the Columbia, and is not inferior to the red salmon for that purpose.

The Dolly Varden trout (*Salvelinus malma*) is miscalled "salmon trout" in Alaska, where it is by far the most abundant of all the trouts, swarming in every stream and lake and about the islands from the Columbia River to Bering Sea. It attains a weight of 8 to 12 pounds, though examples of a greater weight than 1 or 2 pounds are not often seen. It is a fairly good food fish, but is of little economic value except about the towns where it may be consumed fresh, since it can not be taken in such numbers as the canning interests require and it is too small for advantageous sale in cold storage. As a game fish it offers excellent sport to the angler in almost every stream or lake in Alaska. In fresh water the color is rich dark blue or olive, with crimson or orange spots; in the sea it changes to steel gray with spots of paler gray.

This trout is the most persistent and destructive enemy of the salmon eggs and fry. When the red salmon and the humpbacks enter the streams, the Dolly Vardens accompany them in great numbers, and may be seen at the falls and cascades leaping and jumping quite as freely and vigorously as the salmon. They follow the latter to their spawning beds, where they devour the eggs and fry by the millions. The only compensation for the destruction wrought by them lies in the fact that the salmon sometimes feed upon the young trout.

The cutthroat trout (*Salmo clarkii*) occurs sparingly in many streams in southeast Alaska and southward, and is a superior game fish. In Alaska it probably does not exceed 2 or 3 pounds in weight, and is of no importance except to the angler. It is a black-spotted trout, and may always be known by the dash of red on each side of the throat.

The rainbow trout (*Salmo irideus*) has not previously been recorded from Alaskan waters, but was found by the Alaska Salmon Commission in the streams and lakes about Loring and Ketchikan and on Baranof, Chichagof, Admiralty, Kuiu, and Prince of Wales islands. It also occurs in British Columbia, particularly at Texada Island. The species reaches a weight of 2 or 3 pounds, and is the greatest game fish in Alaska, if not in American waters. It may be distinguished from the cutthroat by the absence of red on the throat and the larger scales; from the steelhead by the larger head, larger scales, smaller size, and more rosy coloration. It is not abundant enough to be of any value except to the angler.

The Great Lakes trout (*Cristivomer namaycush*) is common in the Yukon and other waters tributary to Bering Sea, reaching a weight of 30 to 50 pounds in the lakes at the headwaters of the Yukon. It is of some commercial importance as a fresh fish at Dawson and other mining towns in the interior.

The number of species of game fish in Alaska is unusually great. Those of chief interest to the most experienced anglers are the rainbow trout, cutthroat trout, steelhead trout, Arctic grayling, Great Lakes or Mackinaw trout, Dolly Varden trout, silver salmon, and king salmon. Others of somewhat less interest, but whose capture nevertheless affords more or less sport, are the common pike (*Esox lucius*), Alaska cod (*Gadus macrocephalus*), Alaska pollack (*Theragra chalcogrammus*), California tomcod (*Microgadus proximus*), halibut (*Hippoglossus hippoglossus*), rock trout (*Hexagrammos decagrammus*), the Sitka black bass (*Sebastodes melanops*), and several species of rock-fish. The king and silver salmons can be taken by trolling almost any month in the year, but especially in spring and early summer. One of the best regions for this sport is that about Killisnoo.

Steelheads may be taken in the spring—large ones by trolling in salt water and smaller ones with the fly in the streams. Dolly Varden, rainbow, and cutthroat trout may be taken at any time with the fly in many of the streams of Alaska. They are plentiful at Ketchikan, Loring, Killisnoo, Klawock, Shakan, Hunter Bay, and Sitka. The Mackinaw trout, common pike, and Arctic grayling occur in the headwaters of the Yukon, easily reached by rail from Skagway, and the Arctic grayling is found in all the lakes and streams from White Pass to White Horse. It is one of the finest game fishes. The other less important species may be found almost anywhere in southeast Alaska, and may be taken in abundance at any time.

Methods of the Alaska salmon fisheries.—The manner of taking salmon in Alaska for commercial purposes varies with the locality. In general it may be said that the great bulk of the catch is taken by means of traps (or pound nets), haul seines, purse seines, and gill nets, and that the fishing is done in salt water.

In southeast Alaska purse seines, which are simply deep drag seines so hung as to permit of pursing by gathering in the footrope, are used in the more important streams, particularly at Karta Bay, Wrangel, Hetta, and Quadra. The number of these seines seems to be increasing, and they are regarded as a very effective means of capture, most used in narrow, deep channels and where rocky shores preclude the use of haul seines.

Haul seines, or drag seines, are used to some extent in southeast Alaska and to a considerable extent at Alitak and Chignik Bay. At Karluk they are the only nets used. They are effective wherever there are clean sandy or gravelly shores.

Gill nets are used in limited numbers in southeast Alaska at Quadra, Chilkat, etc., and at Chignik. They are effective only in or off the mouths of the larger rivers, whose waters are more or less turbid. In clear water the fish see the webbing and do not gill well.

Traps, or pound nets, are used sparingly in southeast Alaska, more numerously in the northern than in the southern portion, while in Chignik Bay and in Bristol Bay they are used almost exclusively. They are effective when the run is large. An objection to them is that they sometimes take more fish than the canneries can use; moreover, they fish without intermission and take large quantities of other fishes than salmon, such as flounders, pollack, cod, "Irish lords," Dolly Varden trout, and other species, which are all wasted. This is a matter of slight economic importance at present, when there is little or no demand for these species in Alaska, but a trap may be very objectionable when placed in the mouth of a stream by continuously preventing the ascent of salmon to the spawning grounds. Various traps thus located, as in the lagoon of Chignik River, at the mouth of Yes Bay stream, and elsewhere, have been the subject of controversy between the salmon inspectors and the canners. The Yes Bay trap is plainly injurious.

There were in operation in 1903 in Chignik Bay and lagoon 29 traps, so located as to practically close the channel, and the traps in Wood River are open to the same objection. This condition is manifestly not to the best interests of the salmon fisheries and should not be continued. It may be noted, also, that the traps, even in Puget Sound and the Columbia River, where they are most numerous and most extensive, constitute only a small part of the fishing equipment or the obstruction to the movement of the fish. In the Columbia River there were in operation in 1903 731 miles of webbing offering obstruction to the free movement of fish, of which 710 miles are chargeable to gill nets, 5 miles to seines, 1 mile to wheels, and 15 miles to traps. In the Puget Sound and Fraser River region there was a total of 410 miles, of which 375 miles was chargeable to gill nets and only 35 miles to traps. There were 96 traps, all operated on the American side, and 3,000 gill-net boats, all operated in or off the mouth of Fraser River.

It would doubtless be better if all traps, whether fixed or floating, were entirely excluded from salmon waters, but such exclusion would render fishing in some places almost impossible, or at least unprofitable. While the traps are large and numerous in the Columbia, and the gill nets many miles in extent, the supply of salmon in that river is kept up by artificial propagation. In the Fraser River region the traps in the sea take vast numbers of salmon, but in the river itself is a perfect thicket of gill nets, especially immediately following the short weekly closed season. These conditions and the little attention given to artificial propagation in that region account in large measure for the apparent serious depletion of the Fraser River fisheries. Gill-net or trap fishing affects the supply of fish on the spawning grounds just in proportion to the number of fish taken.

Far more destructive to the fisheries than any other form of apparatus was the barricade now happily abolished by the salmon inspectors. This consisted of a permanent obstacle of logs, boards, or netting laid across the stream so that the salmon could not pass, but remained in the pools below, from which they could easily be seined out. The essential evil was that the barrier remained throughout the season, and not a fish could reach the spawning beds. After four or five years (or the period of a generation of salmon) there would be no run of salmon in barricaded streams. This suicidal method was largely practiced in the early days of salmon fishing and canning, and still earlier by the Indians. With the canners it was a phase of the get-rich-quick idea, which has been the curse of Alaska. After long efforts the Treasury Department, through its salmon inspectors, has destroyed all these barriers, and probably none will be again erected.

In the Chilkoot River, and in some other streams, the Indians build stone or wooden stands or platforms in the shallow, swift current, and stones are placed in lines on the bed of the stream in such a way as to compel the fish when on their way up the stream to swim by the stands. When the salmon are running, an Indian stands on each platform, and with a gaff hook on a long pole sweeps to the right and left through the turbid glacial water. The fish can not be seen and are struck at blindly, but considerable numbers are taken in this way.

The fishermen and Indians condemn the pound nets and stationary traps, chiefly because these structures take the place of their own labor. This criticism is applied to all labor-saving devices, and is worthy of no consideration from the economic side.

The canning and salting of salmon.—The first canneries in Alaska were built in 1878, one at Klawock and one at Sitka. Gradually the number increased, until in 1902 there were in operation in Alaska 64 canneries and 19 salteries, and the pack in that year amounted to 2,631,320 cases of forty-eight 1-pound cans each. In 1903 the number of canneries operated was reduced to 60, distributed geographically as follows: Southeast Alaska, 21; Prince William Sound, 2; Cook Inlet, 2; Kadiak Island and Chignik Bay, 8; Bristol Bay, 27. The total pack for 1903 was 2,246,210 cases, valued at $9,748,599.

The salteries are usually establishments of small capital, dealing chiefly with the humpback salmon. In most cases only the belly is salted, the rest of the fish being thrown away. This can hardly be called waste, as the belly is the best part, and the fish swarm in millions. Moreover, all the adults would die after spawning, and at present undoubtedly enough are permitted to spawn to keep up the supply.

In Taku Bay is a cold-storage plant where king salmon, dog salmon, and steelheads are frozen and shipped to the eastern States and to

Germany. There is an extensive oil and guano establishment at Killisnoo. The principal species taken for this purpose is the herring (*Clupea pallasii*), but considerable numbers of humpback and dog salmon are now used both for the oil and for fertilizer. This establishment also salts a good many humpback and dog salmon bellies and herring. The dog salmon bellies are cut small, to conform in size to the humpbacks, and all are sold as "pinks."

Value of the Alaska salmon fisheries.—The vast importance of the salmon fisheries of Alaska is not realized except by those who have given the subject special consideration. The value of the pack for 1903 ($9,748,599) exceeds the original cost of Alaska by more than $2,000,000 and the entire mineral output of the territory for 1901 by nearly $3,000,000. If to the value of the salmon there be added that of the halibut, cod, herring, and other fishing industries, it is evident that the fisheries of Alaska greatly surpass in value all the other resources combined.

Protection of Alaska salmon.—The very large capital invested in the Alaska salmon fisheries and the enormous annual product which those fisheries yield demand that everything possible be done to insure their permanency, and it is evident that to this end the fishes must be given protection commensurate with the destruction from all causes. This must be accomplished in one of two different ways—by actual limitation of the catch, so that a large number of fish may reach their spawning grounds, or by artificial propagation on such a scale that the fish destroyed by the canners will not be missed. These two methods may be considered separately.

In the first place, barricades or obstructions of all sorts in the streams should be prohibited. It is also important that no nets of any kind be used in the smaller streams, like those in southeast Alaska and in the Kadiak region, for in these small streams there are pools and pockets and small lagoons from which, by persistent seining, all the fish could be taken. Moreover, nets can be so placed as to have all the effect of barriers. For the same reason nets and traps should be excluded from lakes and lagoons.

Hook-and-line fishing should be permitted at all times, as the salmon never take food in fresh water, and snap at the hook only when annoyed by it. The Indian spear and gaff may perhaps be permitted in the rivers, because this method has been used from time immemorial, and the number of fish thus taken is inconsiderable.

The streams being free from nets or barriers, other forms of protection are of minor importance. At present there is no pollution of streams in Alaska. There are practically no factories. Lumber is sawed for local consumption only, and the sawmills, usually attached to canneries, are all on the sea. Should they ever be established at

the head of lakes, the spawning grounds of the red salmon will be destroyed. The destruction of the forests above the spawning grounds would be almost fatal to the salmon in the streams concerned. It is, in fact, very important for the salmon industry in southeast Alaska that the government reserve from settlement the catchment basin of every red-salmon stream—at least every red-salmon stream suitable for hatching purposes, thus protecting them from loss of timber, from sawdust, from placer mining, and from pollution from oil wells.

Another form of protection would be the shortening of the fishing season, or making the catch more costly, thus limiting it. Either of these means would be legitimate, and without hatcheries both will be found necessary.

The recommendations of the salmon commission are on the basis of maintaining a permanent industry. The government should not permit private citizens or corporations to destroy future industries for the sake of present gains. It is true that the streams of Alaska, unless injured by mining or lumbering operations, will retain their present character; they can be repopulated when exhausted, and a fishery industry once crippled or destroyed can be restored; but it is far more economical to prevent such destruction, and the government should consider nothing short of it.

The key to the whole question of the future of the Alaska salmon industry is artificial propagation of the red salmon. Under natural conditions the eggs must remain on the spawning beds many weeks, or even months, before hatching, and both they and the fry are attacked by the Dolly Varden trout, sculpins, sticklebacks, and various other enemies, including fungoid diseases. The Dolly Varden trout, which swarms wherever salmon eggs or fry are found, is perhaps the most persistent and destructive. The fish duck also does much damage. So many are the dangers which beset the young salmon that it is doubtful whether one in a hundred, or even one in a thousand, lives to maturity. By artificial propagation practically all of these dangers are eliminated. Almost every egg can be fertilized, the danger of disease can be greatly reduced, all the enemies that feed upon the eggs and fry can be eliminated, and a vastly larger proportion will reach maturity.

The special commission strongly recommends the prompt establishment of at least four salmon hatcheries in Alaska—two in southeast Alaska, one at Afognak Island and one in the Bristol Bay region. These stations should be well equipped in every way for handling 40,000,000 to 50,000,000 eggs each.

Every salmon hatchery in Alaska will require a trained and competent manager or superintendent. One who has learned the business by rule of thumb will not answer; still less one who has not learned

it at all. The supply of properly trained men is still far too small for the work in this country.

It is necessary that the hatcheries be government hatcheries, under the control of the Bureau of Fisheries. The work can not be done in any other way. A hatchery costs as much as a cannery, and only one or two of the strong companies can meet that expense. The feebler ones can not do it. Moreover, but few of the canneries are located where hatcheries are possible, and the Treasury order requiring each cannery to maintain a hatchery is necessarily a dead letter.

A wise administration of the fisheries will permit the taking of the largest number of fish compatible with the maintenance of the supply, and will permit their capture by the cheapest method which is not wasteful. With these conditions in mind we may outline what would have been from the beginning the wisest policy for Bristol Bay, where the conditions are in some respects unique. It is believed that these measures, to a very large extent, are still applicable.

(1) Fishing should be confined to such portions of the bay as are available and to the estuaries at the mouths of the streams. A very large proportion of the fish now captured in Bristol Bay are taken on the grounds here indicated. The only exceptions are Wood River and the Egushak (tributary to the Nushagak estuary), a single trap 35 miles above the mouth of the Kvichak River, and a certain amount of gill netting now prosecuted in the Naknek, Igigik, and Ugashik rivers at points above any reasonable interpretation of the term estuary. A careful inspection of the field has shown that although the companies interested would not voluntarily relinquish any part of the privileges they now enjoy, the privilege of fishing in the upper rivers could be withdrawn without serious injury to any established industry. The proposed restriction is considered of primary and overwhelming importance for the continued maintenance of the fish supply, in the face of present conditions and of those sure to develop in the immediate future.

(2) It would be well if the use of traps or other fixed appliances for the capture of salmon could be prohibited in the Bristol Bay region. If, however, fishing were restricted to the estuaries, the immediate purposes of this prohibition would be largely accomplished. The estuaries are for the most part unsuitable for the use of traps. Storms and the strong tidal currents which obtain there frequently demolish the nets, the muddy water is less favorable for their successful operation than the clear water of the upper rivers, and the floating débris, passing back and forth on the tides, clogs the meshes. The recent history of traps in this district has shown a constant movement out of the estuaries into the upper rivers, nearer and nearer to the immediate spawning grounds of the salmon. During the season

of 1903 but two traps were in successful operation in the estuaries of any of the Bristol Bay rivers, and these two were in especially favorable localities, which could perhaps not be duplicated; but the number of traps in the upper streams has steadily increased.

Although, as has been said, the immediate purposes of the prohibition of traps would be largely accomplished by preventing their use, or that of any fishing device in the upper rivers, it would yet be wise to make the prohibition of traps absolute at this time, when no considerable interests would be imperiled thereby and there are no extensive vested rights opposed to the regulation. There is no question that all the salmon which now or in future can safely be spared from the run of spawning fish can be obtained readily and cheaply by the use of the gill net.

All the considerations that have been urged for the prohibition of fishing in the upper waters, away from the estuaries, apply with especial force to Wood River. This stream, as has been shown, forms the highway to the principal spawning grounds of the red salmon in the Nushagak district. Exclusion of the salmon from these spawning grounds means, it is believed, inevitable disaster to the fisheries, and that such exclusion is being rapidly accomplished admits of no denial. During the summer of 1900 but one fish trap was operated in Wood River (see Moser, Alaska Salmon Investigations, 1902, p. 201), and no record exists of any gill netting in the stream itself. In 1903 no fewer than six traps were in operation, occupying especially favorable localities along the lower 15 miles of the river. In addition, extensive gill netting was resorted to along this same stretch of the stream. The traps are permitted, by the regulations now in force, to obstruct one-third of the channel, while the gill nets average 500 or 600 feet in length. Some reaches of the river in which fishing is carried on by both traps and gill nets do not exceed 800 feet in width. The result is largely the obstruction of the stream to the ascent of fish, an obstruction which becomes almost absolute during seasons when the run is poor or only moderately good, as in 1903; and, bad as are the present conditions, there are reasons for believing that they will grow rapidly worse. Even such cannery superintendents as most sincerely deprecate the folly of the present system find themselves compelled by fierce competition to permit no advantage, however slight, to their rivals, and against their judgment they are now preparing to invade Wood River or other available streams. On account of its preeminent importance, Wood River demands immediate attention. Should the general legislation above recommended fail of enactment, Wood River and lakes should receive special consideration.

In the judgment of the special commission, the statutes governing the salmon fisheries of Alaska should contain the following provisions:

1. Barricades of all kinds in all streams and lakes should be prohibited, except for fish-cultural purposes.

2. In lakes and in streams of the second class—namely, those under 500 feet in width and having a tributary lake—no fishing should be allowed at any time except with rod or spear or gaff, unless for hatchery purposes.

3. No trap or pound net, floating or fixed, should be permitted within 1 mile of the mouth of any stream less than 500 feet in width, and flowing from a lake or having a lake tributary to it. In the case of each stream of this class, the Bureau of Fisheries should mark in some conspicuous way the point above which fishing with nets would not be allowed. Until so marked no fishing should be permitted within 100 yards of the point of discharge of such stream at mean low water.

4. The problem of the use of traps in the large streams and their estuaries is a most difficult one. If we are to consider the ultimate interests of Alaska and the permanence of her salmon fisheries, no traps should be allowed anywhere. They are most harmful where most successful, especially in the flowing streams. The traps in Wood River, and probably those in Kussilof River also, ought to be removed; those in Chignik Lagoon should at least be limited in number. But to remove the traps from those waters would practically close up the canneries depending upon them for their supply of fish; where traps or pound nets are allowed, a special permission and a special license should be required for each, and each should conform to the following provisions: No trap should be nearer than 100 yards to any other, and no trap should extend more than one-third the distance across the stream, estuary, lagoon, or arm of the sea in which it may be placed, and no net of any kind should be set which at the time of setting is within 100 yards of a net set by another person, firm, or corporation.

5. A weekly closed season should be provided, extending from 6 p. m. Saturday to 6 a. m. Monday, for all portions of Alaska, except in Bering Sea and its tributary waters.

6. All matters pertaining to the salmon and all other fisheries of Alaska, including the fur seal and sea otter, should be placed in the hands of the Commissioner of Fisheries, under the Secretary of Commerce and Labor. The personnel of the Bureau of Fisheries should be correspondingly increased, and means provided in the way of vessels for travel, to render effective the inspection of the fisheries, the investigation of the streams, and the operation of the hatcheries. The necessity for expert service, if this inspection is to be maintained, is self-evident. It demands a knowledge of the fishes, of the fisheries, of fishery apparatus, methods, and products, of statistical methods, and the methods and results of fish culture—different kinds of expert knowledge which can not often be in the possession of one man.

Unless trained men familiar with fishes and fishery gear, methods, and products are placed in charge of this work the office of fishery inspector should be abolished.

7. Power should be given to the Secretary of Commerce and Labor to make, as occasion requires, such minor regulations as may be deemed necessary for the good of the industry, including the closing of streams and lakes and of their approaches, these regulations to be made on full consideration of the various ways in which different fisheries may be affected.

In justice to the fishing interests of Alaska it is important that all these matters receive early consideration. All necessary legislation and regulations should be perfected and promulgated as soon as possible, so that the canning companies may know the conditions under which the fisheries are to be carried on next season and make their plans accordingly.

THE COD FISHERIES OF THE SHUMAGIN ISLANDS.

Representations having been made to the Bureau that the cod fisheries centering at the Shumagin Islands were becoming depleted, those islands were visited by the Alaska salmon commission and inquiries made concerning the condition of the fishery. It was found that the difficulty of securing remunerative fares is increasing year by year. Until recently an abundance of fish was found in the immediate vicinity of the islands, but now the fishermen are compelled to go much greater distances and the fish average smaller than formerly. It is believed by the special commission that the establishment of a cod hatchery at Sand Point, Pirate Cove, or some equally good location at the Shumagin Islands would not only conserve this important fishery, but build it up to proportions exceeding any previous condition. Such a station would be easy of construction and operation, and its establishment is strongly recommended.

FISHES OF THE YUKON RIVER.

Collections were made by the Alaska salmon commission in the headwaters of the Yukon, at Caribou Crossing, Yukon Territory, Lake Bennett, and White Pass. Nine species of fish were found, as follows: The Mackinaw trout (*Cristivomer namaycush*), pike (*Esox lucius*), Alaska grayling (*Thymallus signifer*), sucker (*Catostomus*), blob (*Cottus*), white-fish (*Coregonus*, 2 species), and white-fish (*Argyrosomus*, 2 species). The inconnu (*Stenodus mackenzii*) was not seen. This is the first collection of fishes made in the upper Yukon.

INVESTIGATIONS IN MAINE.

The fresh waters of this State have been under investigation for the past few years, and some of the results were recorded in the last annual

report of the Bureau. The work has been in charge of Dr. W. C. Kendall, who has continued his inquiries during the past fiscal year.

Eagle Lakes of Aroostook County.—Twenty-six species of fishes were collected in this region, a greater number than has been found in any other locality of like extent in Maine. The food fishes are chiefly members of the salmon family, and include the landlocked salmon (*Salmo sebago*), lake trout or togue (*Cristivomer namyacush*), square-tail trout (*Salvelinus fontinalis*), and white-fish (*Coregonus labradoricus*, *C. stanleyi*, and *C. quadrilateralis*). Species conspicuously abundant in the southern half of the state, such as eels, yellow perch, white perch, and pickerel, do not occur in this chain of lakes, although yellow perch are not uncommon in the St. Johns River, of which Fish River, in this region, is a tributary.

The landlocked salmon, steelhead trout (*Salmo gairdneri*), and smelt (*Osmerus mordax*) have been introduced here. The steelhead has not since been recognized, but in about ten years the salmon has increased greatly in numbers and attained large size, due to the peculiar suitability of these waters to its needs, and doubtless also to the introduction of the smelt, upon which it feeds. In about five years the latter species has attained a length of 12 or 13 inches, as ascertained by actual measurement.

Of the three species of white-fishes here represented, *Coregonus labradoricus* is the largest. It reaches a weight of at least 6 pounds, and is very abundant. Another form (*C. stanleyi*, until recently undescribed) is much smaller, attaining a weight of scarcely more than one-fourth pound, but is extremely numerous. It, with the young of the others and the smelt, probably affords the bulk of the food of the trout and salmon. The round white-fish (*C. quadrilateralis*) was found to reach 1 pound in weight, but seemed to be not abundant.

This region was visited again in November, 1903, for the purpose of ascertaining the identity of a large trout locally known as the "snowshoe trout," and to study the breeding habits of the various species of *Salmonidæ* occurring there. It was considered of importance to fish culture to determine the feeding habits of these fishes at their spawning time.

On several occasions young salmon (*S. sebago*) 6 or 8 inches long were observed eating the eggs of trout (*S. fontinalis*) as they were deposited. No salmon were observed upon the spawning grounds, owing to their being taken in a weir for fish-cultural purposes by the state commission. White-fish ascended the streams, or "thoroughfares," at night for the purpose of spawning, and were followed by large numbers of suckers (*Catostomus commersonii*), which were found feeding upon the eggs. A few small cusk (*Lota maculosa*), also, were eating the eggs of white-fish, and it was learned that adult white-fish feed largely upon the eggs of their own kind and the young upon

the eggs of the other species. Not only would spent fish follow up the spawning fish and eat their eggs, but gravid females were found to do the same thing. The breeding times of the common white-fish and Stanley's white-fish were supposed to overlap because the species were captured together, but it appears that the earlier spawner (*C. stanleyi*) was probably there at this time mostly for the eggs of the common white-fish.

In this locality there are no commercial fisheries, but occasionally the native French inhabitants are allowed to net the white-fish under restrictions. The fishing as now regulated is chiefly important to the sportsman, but the abundance of the white-fish in a lake system of such extent suggests a possible commercial fishery under proper regulations, which would afford to the inhabitants of Aroostook County at least a delicious fish for the table, both fresh and cured. A limited net fishery, restricted to the summer months and to certain localities, would do no more damage, if as much as is done by fishing on the spawning beds, which is now permitted.

Union River basin, in Hancock County.—In August and early September the Union River basin was visited and the general fish fauna of the region, especially Green Lake, Branch and Floods ponds, was investigated. Attempts were made to secure specimens of the Floods Pond saibling, locally known as silver trout, supposed to be *Salvelinus aureolus*, but without success, although various methods were tried. In June, 1904, however, another visit was made to Floods Pond, and a good collection of this fish was secured. From information furnished by reliable men and from observation, it appears that the silver trout is very much scarcer than formerly, and the fish now caught are not so large. There seem to be but a few weeks in May and June when they will take a hook. The usual method of fishing is by hand line in from 30 to 40 feet of water on the outer edge of a reef, the best bait, as a rule, being cut chub and fresh, uncooked lobster, though occasionally a fish is taken at or near the surface or in deep water on a troll, and by live minnow or worm bait. This trout is a rich, fat, and delicious fish at this time of year.

The stomachs of the specimens examined this season usually contained small smelts. Many were infested with small tapeworms, large numbers often being found in the alimentary tract of a single fish.

Rainbow Lake, in Piscataquis County.—The Bureau having received two specimens of a peculiar trout from Rainbow Lake, closely related to if not identical with the so-called silver trout of the Union River basin, though of a smaller size, it was considered desirable to visit the locality in an effort to obtain more and better specimens and to make a study of the lake and its inhabitants.

Although quite large, being about 7 miles long by 2 or more miles in extreme width, and fairly deep in places, Rainbow Lake has a very

meager fish fauna. Apparently the only species other than the common trout and the above-mentioned peculiar trout, is a small minnow (*Rhinichthys atronasus*). The two trouts attain only a small size, seldom over a pound in *S. fontinalis* and still smaller in the saibling. This is probably due to scarcity of food.

Presumpscot and Royal River basins.—In these waters and the brooks tributary to Casco Bay, special attention was given to smelts, trout, and landlocked salmon. There are often found in June, in the tidal portion of many of the brooks flowing directly into Casco Bay, some silvery trout otherwise indistinguishable from *S. fontinalis*, and sometimes known as "salters." Some of these fish caught about the middle of June were found to be gorged with young eels of the translucent stage. It was a mooted question among the trout fishermen of the locality whether the fish came up from the sea or descended from the fresh water.

In June, 1904, an attempt was made to solve the question. Seines were used in the pools frequented by the trout at different times of tides, and trials were made with hook and line for a long distance below the places usually fished. The fish were found only in those pools a short distance below high tide limit. While the water is rather salt at flood and high tide, it is practically fresh at low water; the seines took alewives (*Pomolobus pseudoharengus*) and suckers (*C. commersonii*) in the pools mentioned. These facts taken together indicate that the trout have descended from the fresh water.

Smelts begin to ascend the brooks, when the conditions are suitable, in the last part of March or early April. The runs continue sometimes up to the 1st of May or later. After spawning, the fish linger in the brooks for some time, gradually decreasing in numbers, and not infrequently dead fish are found. All of the specimens collected were spent males. While it was not positively decided whether the death of these fish was due to natural causes or to injury received from fishermen, the abundance of dead, dying, and fungus and copepod infested smelts found in fresh water shortly after the breeding season suggests that many smelts die naturally after spawning.

During spawning, and afterwards while in fresh water, food is seldom found in the smelts' stomachs, though an occasional minnow is met with. In one brook sticklebacks and small trout were feeding upon the eggs, and in the stomachs of the trout sand was mixed with the eggs, probably scooped up with them. In another brook, after the smelts had disappeared, four species of sticklebacks (*Pygosteus pungitius*, *Gasterosteus aculeatus*, *G. bispinosus*, and *Apeltes quadracus*) were found filled with recently hatched smelts. Though the mummichog (*Fundulus heteroclitus*) was numerous here, no young smelts were found in the stomachs.

In the spring of 1904, in a brook in Freeport, where in recent years the smelts had not appeared except occasionally in very small numbers, there was a large run, much like the runs of twenty or twenty-five years ago; but owing to the lack of protection on their spawning grounds these fish were taken in such numbers that probably few, if any, spawned there.

INVESTIGATIONS IN WESTERN WASHINGTON.

During the winter of 1903-4 investigations were conducted at American Lake and other small lakes in the vicinity of Tacoma, Wash., by Mr. J. Nelson Wisner, of the division of fish culture, for the purpose (1) of determining the physical characteristics of the lakes, including the character, temperature, and depth of the water, character of shores, catchment basin, inlets and outlets, with a study of local meteorological conditions, and (2) of studying the animals and plants inhabiting the different lakes, including a determination of the species and a study of their life histories. Particular attention was given to the fishes and the adaptability of the lakes to the white-fish and other species which have been introduced or whose introduction has been contemplated. The inquiries covered more or less fully the following waters:

American Lake.—This is the largest lake of the group, being approximately 4 miles long and averaging 1 mile in width, with a minimum width of less than 100 yards at the narrows joining the larger basin to the smaller, which forms the southwest portion of the lake, lying toward Lake Sequallitchew. The outline is irregular, the major axis of the lake lying northeast and southwest. The shore line is a continuous series of indentations, small coves abounding, with some 12 or 15 larger ones. The shores are low and in most places are well wooded, as is also the catchment basin, which probably does not exceed three times the area of the lake itself.

Murray Creek is the only surface inlet to American Lake, and near its mouth is about 16 feet wide and 6 to 8 inches in average depth. It is only a few miles in length and enters the lake from the southeast. The water comes largely from springs and is clear and pure. There appears to be no surface outlet to the lake, the drainage probably being into Sequallitchew Lake by seepage.

The average depth of American Lake, based on 42 soundings, is 67 feet; the maximum depth, 106 feet. Usually the depth increases abruptly and close to shore. Temperature observations made from March 30 to April 15 show 82.5° as the maximum for the air. The surface of the water varied from 46 to 59°, the morning (6 o'clock) temperature running from 46 to 52°; the bottom temperature was found to be about 48°.

The water of this lake is clear and pure and well suited to ordinary lake fishes. The species observed were chubs, sculpins, black bass (introduced), sticklebacks, suckers, and cutthroat trout. The chubs were spawning; the spawning season of the trout had passed. Bass thrive in this lake and attain a weight of at least 4 pounds. Trout are plentiful and reach a length of 12 to 18 inches. A species of mud turtle, a salamander, and a fresh-water mussel were found to be abundant.

The Bureau has planted in various lots 637,000 common white-fish (*Coregonus clupeiformis*) in American Lake. None of the fish has been seen since, and it is not known whether any has survived. The physical characters do not indicate that this water is suited to the species.

Steilacoom Lake.—This lake is next in importance to American Lake, and its general characteristics are similar. Its greatest length is about 1.75 miles, and its greatest width less than one-half mile. Clover Creek and Davidson Creek both flow into it near the southern end on the east side. The former is a considerable stream, and is said to drain Smith, Tule, and Spanaway lakes, which lie to the southeast. The outlet of Steilacoom Lake is through Chambers Creek into Puget Sound just north of Steilacoom. The water is shallow, the maximum depth being but 17 feet, and the average of 17 soundings being only 12 feet.

This lake is of interest chiefly because of the fact that the so-called small red-fish occurs in it. The species is said to be seen only in October, at which time it is gaffed in considerable numbers. Whether it comes up from the sea is not known to the local residents. The other fishes of the lake are chubs (two species), cutthroat trout, large-mouth black bass (introduced), sculpins, and sticklebacks.

Sequallitchew Lake.—Southwest of American Lake and only a few rods from it is Sequallitchew Lake, which is about 1.5 miles long and less than one-fourth mile wide, and has a maximum depth of about 17 feet. It has no tributary streams, and its outlet is through Sequallitchew Creek to Puget Sound. The shallow, muddy bottom and the high temperature of the water do not indicate that this lake is suited to white-fish. It is, however, a fairly good trout lake, the cutthroat trout being abundant.

BIOLOGICAL INVESTIGATIONS ON THE COAST OF CALIFORNIA.

Early in the calendar year 1904 arrangements were perfected which provided for a cooperation of Stanford University and the University of California with the Bureau of Fisheries in a physical and biological survey of the waters of the coast of California, and the steamer *Albatross* was assigned to the investigation. General direction of the work was placed in the hands of President David Starr Jordan, of Stanford

University, and Dr. William E. Ritter, professor of zoology in the University of California.

The investigations were begun at San Diego March 1, 1904, and were carried on in that vicinity for more than one month. Various localities on that part of the coast were examined, especially Cabral Bank and vicinity and the deep water beyond the 2,000-fathom curve. La Jolla submerged valley and the region about Coronado Island also received attention. In all, 82 dredging and 12 plankton stations were occupied, and plankton work was done at many of the other stations. Considerable attention was given to certain hydrographic matters, and current observations were continued for several days on and in the vicinity of Cabral Bank with interesting results. Numerous soundings in this locality resulted in establishing the extension of Cabral Bank several miles farther northward than it appears on the Coast Survey charts. As this bank is the chief fishing ground in the San Diego district, this discovery is regarded as one of the most important results of the month's work.

The few dredge hauls made beyond the 2000-fathom curve proved of much interest. The abundance of life and the character and conformation of the bottom indicate this to be a field promising very rich results. Mention should also be made of the few hauls in the 1000-fathom sink between Point Loma and Cortez Bank. These mark a locality which also promises interesting results for future examination.

Certain areas, particularly the Coronado submerged valley, were found to be very rich in bottom life, while others proved rather barren. One of the interesting problems for future inquiry in this region will be to determine accurately the areas of distribution and to correlate this distribution with the conformation of the bottom and the character of the bottom deposits.

The groups of animals most abundantly represented, both as to species and genera, and individuals, were found to be the glass sponges, the actinians, all the classes of echinoderms excepting the crinoids, and the crustaceans. The fish fauna is not particularly rich nor varied. A large quantity of plankton material was collected, though the work in this field was less satisfactory than the bottom collecting.

After the completion of the work about San Diego, some investigations were made off the Santa Barbara Islands in order to connect the San Diego work with the investigations which were to be taken up at Monterey Bay.

The survey of Monterey Bay was carefully planned, and occupied the remainder of the fiscal year. The Coast Survey signal stations were reestablished, thus making it possible for all dredging and other stations occupied by the *Albatross* to be accurately indicated upon the chart. The geographic distribution of the various species inhab-

iting the bay received consideration, and that of the sessile or fixed species can be accurately platted on the map.

INVESTIGATIONS IN ARIZONA.

Early in January Mr. Fred M. Chamberlain, naturalist of the steamer *Albatross*, was detailed to study the physical and biological features of the Gila River basin in Arizona. Observations were carried on at Yuma during the last half of January and the month of February, and during March and April visits were made to most of the streams in the Gila basin. The physical characteristics of the streams were determined and their suitability for fish-cultural work fully considered, it being important that these streams be examined before irrigation operations shall have seriously modified their character. The results of these observations will be given in detail in a report now in course of preparation.

INVESTIGATION OF SMALL LAKES OF NORTHERN INDIANA.

The examination of the small lakes of northern Indiana, begun some years ago, was continued during a portion of the summer of 1903 and for a few days in June, 1904. The investigations of the present fiscal year, as heretofore, were under the general direction of Dr. Barton W. Evermann and were carried on by Dr. J. T. Scovell, of Terre Haute, Ind. The inquiries were directed chiefly toward securing data concerning the food of the various food and game fishes occurring in these lakes, and, second, toward determining the species and habits of the aquatic plants and their relation to the animal life of the same waters. The principal investigations were carried on at Lake Maxinkuckee, but more or less work was done at Bass Lake, Lake Manitau, Tippecanoe Lake, and Twin Lakes.

DISEASES AND PARASITES OF FISHES.

The study of the diseases and parasites of fishes was continued by Mr. M. C. Marsh, assistant assigned to the subject of fish pathology, and a number of special investigations were made at different fish-cultural stations of the Bureau.

The gas-bubble disease.—The mortality from this cause at Woods Hole, Mass., and at Nashua, N. H., received attention in the summer of 1903. August and part of September were spent in investigations, supplementing those already published, and, jointly with Prof. F. P. Gorham, of Brown University, some important additions to the subject were made. Simple methods of de-aeration of water supercharged with dissolved air were again effective at Woods Hole in preventing symptoms of this disease, and, later in the year, when the leaky suction pipe supplying the aquaria and hatching tanks had been replaced by a new, impervious one of iron, all trouble from gas disease disappeared.

At the Nashua station the investigations were continued in the spring of 1904. They were directed chiefly to the water supply and consisted of determinations, made at the station, with field apparatus, of the dissolved air in samples of water taken from many different sources of the station's water system. The results of these analyses show that the whole station water supply except the Pennichuck, or Nashua city water, has an abnormal content of dissolved air. All such sources of supply are abnormally high in nitrogen and some of them are at the same time deficient in oxygen. The constantly flowing supply is mainly from two sources, one being artesian wells, the other a large reservoir pond fed chiefly by springs. This latter supply is in somewhat better condition by the time it reaches the fish ponds or troughs than is the artesian supply. In no case is the excess of nitrogen very high, and in only a few is the deficiency of oxygen very great, but either is enough to cause some loss of fish and the effect of the combined evils is believed to be mainly responsible for the mortality among younger fish at the station and for the poor condition of some of the adult stock.

The fact that water with an excess of nitrogen is unhealthful for fishes, and that it may be corrected and rendered harmless by a sufficient exposure to the air, is shown more by the experience at the Woods Hole station than at Nashua. At Nashua it is not easy to apply this remedy on a large scale. One experiment, however, indicates that it has a like effect. Two troughs, each containing 6,000 to 7,000 brook-trout fry, were supplied with water form the reservoir pond. One was lowered to the ground and the water entered it from a box with a finely perforated bottom and after a fall of some 3 feet. In the other, the water entered more directly. At the end of nine days the loss in the former trough was 645; in the latter 2,583. The exposure of the water to the air had evidently reduced the loss 75 per cent. The device reduced the nitrogen and increased the oxygen, but not all the excess of nitrogen was removed nor did the water become quite saturated with oxygen. Without doubt, were the exposure process carried further, perhaps by one or two repetitions, all the excess of nitrogen would have been removed and the full amount of oxygen added, but on account of the lack of sufficient fall this can not be done. While a deficiency of oxygen is readily corrected by fall and exposure, it is with difficulty that an excess of nitrogen is completely removed. It appears, nevertheless, from the analysis of the creek outflow, which is the whole Nashua supply after it has flowed through the ponds, flumes, etc., that this water has been almost completely corrected of its air defects. Therefore it might be used again, and if the hatchery and ponds were moved to a point below, a good supply would be at hand. But this is not to be advised. If there were provided a fall considerably greater than at present is possible, and the whole station

supply were brought together, the trouble could then be corrected by devices that would afford an extensive contact with the air. This would require a pumping plant to raise the water, and the plan would probably be best carried out by digging one or more large wells which would increase the volume of supply and gather it convenient for pumping. This, however, would be expensive in first cost, and a continuing expense thereafter, and is not to be recommended.

The simplest, least expensive, and best plan for increasing and improving the water supply of the station is believed to be to tap Colerain brook and bring its water to the hatchery. This brook rises in the drainage ditches of a meadow, and flows some 2 miles to the Nashua River. It is at present a somewhat depleted trout stream, and its water is to all appearances of suitable quality for fish-cultural purposes. Two determinations show it to have a proper content of dissolved air, which could hardly fail to be the case, since it is a small brook well exposed to the air by its length and the nature of its bed. Shortly before reaching the river it skirts closely the Fisheries reservation. The volume of water carried by it is subject to considerable seasonal variation, but is greatest in the winter and spring when most needed, and if carried to the hatchery would probably be sufficient to provide for all the eggs. It could be supplemented by Pennichuck water if necessary. The water of all the hatchery wells could then be diverted directly into the ponds—without flowing through the troughs—and at the same time could be aerated and de-aerated considerably on the way. Since the Colerain supply can itself be turned into the ponds from the hatchery troughs, the water of the ponds will be very greatly improved. The artesian wells rising in the ponds themselves can in most cases not be improved, since they scarcely rise above the level of the pond water, and experience may show would be better plugged up. This may apply also to the larger wells rising in the ponds.

With the Colerain supply available for the hatchery, the water of the reservoir pond could be applied to the fish ponds only, as it is at present in part. It receives considerable exposure to the air in the flume on the way to the ponds. This addition to the water supply of the station is expected to prevent most of the losses now occurring each season.

Plans and estimates are already available, the route from the brook to the hatchery having been previously surveyed by the engineer's office for the purpose of supplying the hatchery. The project was abandoned at that time in favor of Pennichuck water, the use of which entails an expense at meter rates and is not intended to be continuous.

It is interesting to note that the Pennichuck water which supplies the city of Nashua is, at its source in artesian wells, greatly deficient in oxygen and has a marked excess of nitrogen, and would certainly kill brook trout. In its course to the pumping station it is thoroughly

exposed to the air by its flow as a creek of many falls and cascades, and this corrects it completely.

Water supply at White Sulphur Springs station.—A visit was made to White Sulphur Springs station in January and February to investigate the mortality among trout fry there. It was shown that the station water varied from time to time in its supply of dissolved oxygen, and was for a part of the time markedly deficient in oxygen. There was possibly at the same time a deficiency in the nitrogen dissolved, but the necessary apparatus to determine this was not available at that time. An aerating and de-aerating apparatus on a small scale was put in practice by lowering one trough to the floor and passing its supply through a perforated box, the water falling a few feet in slender streams. This arrangement caused a marked reduction in the losses, but did not entirely prevent them. The presumption is that a more complete process of the same sort would correct the water entirely.

Mortality at Allentown, Pa.—In October and November study was made of a mortality among brook-trout fry at the Allentown hatchery of the Pennsylvania Board of Fish Commissioners. The disease proved to be an anæmia which was finally ascribed to long continued housing of the fry in large numbers in hatchery troughs. The progress of the disease in the affected brood could not be arrested, but terminated naturally, leaving a considerable percentage of fry in apparently good condition.

Contamination of oysters at Great South Bay, Long Island.—Representations having reached the Department of State through certain officials in London that oysters received from New York were contaminated with sewage and presumably with typhoid germs, the matter was taken up by the Bureau, and in February an examination was made of certain oyster beds at Great South Bay, from which the contaminated oysters were alleged to have come.

Oysters freshly taken from the beds named, and similar oysters held for two or three days in floats on the bay shore were examined bacteriologically and were wholly free from sewage contamination. At Patchogue, oyster beds were found exposed to sewage, and though oysters taken from them were also free from sewage at this time, some danger must have existed, especially at other seasons. The practice of floating oysters close to shore, even when not at the mouths of creeks or rivers, was found to be more or less a menace to the health of oyster consumers.

The oysters alleged to have been impure were taken in November and December, while the investigation was made in February following. Though the beds were then found free of contamination, the method of floating the oysters near shore might easily result in their contamination during the warmer months of the season, and it is

regretted that the region in question can not be entirely free from suspicion of having sent out polluted oysters. The situation is fully appreciated by the oyster dealers and the local authorities, and it is believed no further danger need be feared.

Disease at Cold Spring Harbor, New York.—In May and June a visit was made to the Cold Spring Harbor station of the New York Forest, Fish and Game Commission, to examine into the cause of a serious mortality among yearling and adult brook trout. This was determined to be due to a parasite, *Lymphosporidium truttæ*, described by Professor Calkins. The disease destroyed nearly all the older trout, and advanced, entirely unchecked by remedies. It is believed to be amenable to control as respects future outbreaks by cementing the ponds, by the practice of disinfection to kill all stages of the parasite, and by avoiding too heavy a stock of yearling and older trout.

Menhaden mortality in Narragansett Bay.—In May and June an extensive mortality among menhaden occurred in Narragansett Bay, and the disease was also found at New Bedford. By the last of June the mortality seemed to have ceased. Prof. F. P. Gorham, of Brown University, investigated the disease by making cultures from the dying or dead menhaden, and obtained a bacterial organism in all cases. At the close of the fiscal year he was studying the relation of the organisms to the disease.

Besides the more detailed inquiries, Mr. Marsh made special investigations concerning diseased fish, contaminated water supply, and other difficulties besetting fish-cultural operations at Northville, Mich.; Wytheville, Va.; Erwin, Tenn.; Allentown, Pa.; and Nashua, N. H. During the spring of 1904 an exhibit of bacterial organisms pathogenic to fishes and of others related to the fisheries was prepared for display at the Louisiana Purchase Exposition.

WOODS HOLE LABORATORY (DR. F. B. SUMNER, DIRECTOR).

The laboratory of the Bureau at Woods Hole, Mass., was thrown open on the 16th of June, 1903, for the nineteenth summer since the establishment of its present quarters, and scientific work was in progress until the end of September. The work accomplished during the season is summarized below, together with especial mention of certain important lines of work which were planned and commenced.

Equipment.—In addition to the large laboratory room with 9 tables, there were 14 private rooms at the disposal of investigators, all of which are provided with gas and electricity, and otherwise equipped for research. To this must be added the library, supply room, and aquarium, as well as the main hatching room, which, as usual, was available for laboratory purposes from the end of the lobster-hatching

season, early in July, and certain other portions of the fish-cultural plant which were also at the service of investigators. Early in the summer important improvements were made in the plumbing of the main laboratory, and some others have been authorized which will be completed before the opening of another season.

The steamers *Fish Hawk* and *Phalarope*, the launch *Blue Wing*, and two smaller launches were available during the whole or part of the season; also a catboat and an abundance of rowboats.

Fish pounds were set this year in Buzzards Bay at points not far from the station. A daily record was kept of the species taken, together with a rough estimate of the number of each. Such records, which have been kept for many years past, furnish valuable data concerning the annual migration of fishes. The pounds also constitute one of the important sources of supply for the materials of investigation.

One floor of the large residence building was, as usual, at the service of those employed by the Bureau to carry on special investigations.

Staff.—The staff of the laboratory during the season comprised a director, a librarian, a secretary, five salaried investigators, working upon special problems of interest to the fisheries; an assistant in charge of the supply room, an assistant in charge of the fish pounds, and nine assistants employed in miscellaneous work in the laboratory and in the field. To the above list must be added a collector, who is permanently attached to the station, and the crews of the various vessels while these are in the service of the laboratory.

Collecting trips.—Leaving out of account the daily visits to the pound nets, about 40 collecting trips were made by the smaller steam craft to various localities in the vicinity, and 15 dredging trips by the *Fish Hawk*, whose operations were confined almost exclusively to Vineyard Sound. Mention should also be made of the work of two assistants in camp at Menemsha Bight, Marthas Vineyard, where they were engaged for four days in noting the fish taken in the numerous traps at that point, and of a journey to Provincetown in quest of data relating to the food of the dog-fish. The collection and preservation of fishes, fish parasites, and other material of biological interest was continued as usual.

Seminar.—A seminar, or research club, was established early in the season, and thereafter met weekly until near the close of the summer. It was thought that cooperation might be profitable in certain lines of research, and in general it seemed desirable that there should be some recognized medium through which the investigators might profit by the results of each other's work. The experiment proved entirely successful, and the meetings were well attended.

Catalogue of local fauna and flora.—The completion of a catalogue of the fauna and flora of the region as far as known was commenced by the director in cooperation with several others. The work as

projected contemplates much more than a catalogue in the sense of a mere list of species; certain data of practical or scientific interest are, when available, recorded for each animal and plant form. In order to admit of indefinite expansion, the whole record will be put in the form of a card catalogue, with eleven cards for each species. A fair start has already been made in this work, many of the principal reports and synopses having been abstracted, and records of about 750 species having been entered.

Biological survey of Vineyard Sound.—The *Fish Hawk* arrived at Woods Hole on the 19th of July and remained until September 10, during the greater part of which period she was at the disposal of the laboratory. It was thought that the admirable facilities for dredging possessed by this vessel could be put to greatest advantage by carrying out a systematic survey of the bottom of Vineyard Sound, a task which had not been undertaken since the days when Professor Verrill and his associates gathered the material for their reports on the invertebrate fauna of these waters.

Accordingly, dredgings were made at intervals of three-fourths of a mile along parallel lines crossing the sound, these lines being 1 mile apart. Various sorts of dredges were employed, according to the character of the bottom; the usual physical data—density of water, character of bottom, temperature, etc.—were recorded for each station, and material for a complete record of the biological data was preserved. In all, 82 stations were occupied in Vineyard Sound, ranging from Nobska Point to Gay Head. It is intended that these dredgings shall be continued and supplemented by thorough work upon the shore life of this region, thus completing a biological survey of these waters. The relation which such a survey would bear to the catalogue above discussed is obvious.

In addition to the above dredgings, a trip was made to Crab Ledge, a shoal about 7 miles east of Chatham, on Cape Cod, where 7 stations were occupied.

Miscellaneous investigations.—The results of the following investigations, which were conducted wholly or in part at the laboratory during the summer of 1903, will be embodied in special reports to be published by the Bureau:

1. The stomatopoda of the *Albatross* Hawaiian expedition. 2. Brachyura of the Woods Hole region. By Robert Payne Bigelow, Ph. D., instructor in biology, Massachusetts Institute of Technology.

Studies upon carp. By Leon J. Cole, Austin teaching fellow in zoology, Harvard University.

The food of certain fishes of little or no food value. By Irving A. Field, Denison University.

Causes of certain fish diseases. By Frederic P. Gorham, Ph. D., associate professor of biology, Brown University.

The parasites of fishes. By Edwin Linton, Ph. D., professor of biology, Washington and Jefferson College.

Physiology of the lateral-line organs of fishes. By George H. Parker, Ph. D., assistant professor of zoology, Harvard University.

A synopsis of the annelids of the Woods Hole region. By J. Percy Moore, Ph. D., instructor in zoology, University of Pennsylvania.

The total number of investigators who availed themselves of the privileges of the laboratory during the summer was 30, the greatest number at any one time being 20. These men represented two government departments and 16 educational institutions, ranging from Alabama to Vermont and west to Illinois. The nature of their investigations is indicated below:

Artificial sea waters as tested in aquaria.—At the suggestion of Mr. W. de C. Ravenel, representative of the Bureau of Fisheries at the St. Louis Exposition, experiments were made under authority of the Secretary of Agriculture and of the Commissioner of Fisheries, to determine, if possible, how far it may be practicable to make artificial sea water capable of sustaining marine plant and animal life. This work was conducted by Dr. Rodney H. True, physiologist of the Department of Agriculture, assisted by Mr. W. O. Richtman, of the Department of Agriculture, and Mr. Grant Smith, graduate student of Harvard University.

Experiments were made with artificial sea water prepared in two ways: (1) By dissolving in distilled water the complete salts of the sea, obtained by evaporation; (2) by dissolving in distilled water chemically prepared salts in proportions determined by analysis. The *Challenger* analyses by Dittmar were used. Aquaria were provided with artificial waters prepared according to each of these methods and with sea water dipped from the current at the end of the wharf at the Woods Hole station. Two sets of such aquaria were prepared: (1) Standing aquaria kept at constant salt content by the addition of fresh water; (2) aquaria through which a small stream of water was kept flowing, providing thereby a system of closed circulation.

Aquaria thus prepared were stocked with both plant and animal life, the plants most used being green forms common at Woods Hole—*Cladophora*, *Enteromorpha*, *Ulva*, and *Aghardiella tenera*. Many types of animal life were studied, including especially sea anemones (*Metridium*), starfish (*Asterias*), medusæ (*Gonionemus*), squid (*Loligo*), and fish (silversides, scup, pipe-fish, etc.). The general result may be stated as follows: Sea anemones seemed to flourish in all the media during the period under observation. Starfish survived and behaved normally in the water made from evaporated sea salt, but in some cases showed symptoms of injury in the synthetic solution. *Gonionemus* survived for several weeks in both solutions, but appeared to suffer from its contact with other forms of life in the aquaria. The squid could not be made to survive for more than a few days in any medium, artificial or natural. It died in the synthetic solution in less than ten minutes, with violent symptoms, but survived in the other artificial solution as long as in the natural sea water. Fish, including delicate forms like *Menidia*, seemed in all cases to live as well in the artificial solutions as in the natural. Several other forms of fish and invertebrates were tested in various ways, with the general result that the artificial solution made from the salt obtained by evaporation permitted survival to a degree not clearly different from that seen in sea water. The synthetic artificial solution seemed equally favorable to most forms, but distinctly less so to a few.

The edible lamellibranchs as a source of infection.—This research was conducted by Dr. George Wilton Field, of the Massachusetts State Board of Health, assisted by Dr. C. A. Fuller, and involved a study of the relations between shellfish and sewage bacteria, with experiments designed to answer the following questions: (1) Are

sewage bacteria (*Bacillus coli*, the type form) normal and usual inhabitants of shell-fish? (2) How soon after the introduction of *B. coli* into the water does it appear in the clam? (3) How long does *B. coli* live in ordinary sea water? (4) How long, under normal conditions, does *B. coli* remain alive and active in the intestine of shell-fish? (5) Is it probable that the shell-fish digest *B. coli* and thus incidentally act as purifiers of the sewage-polluted waters, and further, that by digesting *B. coli*, shell-fish may after a time become free from sewage bacteria and therefore harmless as food for man? (6) Examination to ascertain what anatomical region is most certain to give a true index to the presence of *B. coli.*

The methods used by Doctor Field and Doctor Fuller for securing proper conditions of infection with *Bacillus coli* and for maintaining the normal conditions of life for the clams proved satisfactory. The results will probably be published by the Massachusetts State Board of Health in its annual report and are believed to be of considerable importance.

The lobster problem.—At the request of Capt. J. W. Collins, chairman of the fish and game commission of Massachusetts, Doctor Field secured at Woods Hole and Cuttyhunk important data concerning the lobster industry, bearing upon the biological importance of preserving the adult lobsters and permitting the catching of immature ones. Figures were obtained indicating the commercial value, in terms of edible meat, of lobsters 8.5, 9.5, and 10.5 inches long; also the weights and measurements (length, weight, and diameters of chelæ, thorax, and abdomen) of upward of 800 newly caught lobsters coming from different sections; and some observations were made upon the relative numbers of mature and immature lobsters in the ocean. In connection with the recommendation of a law which would insure the perpetual protection of the adult lobster, experiments were made looking toward the adoption of a pot which would exclude lobsters above 11 inches in length and permit the escape of those under 9 inches. The result of this would be the automatic regulation of lobster catching to practically only those sizes between 9 and 11 inches.

The food of marine birds.—Lynds Jones, M. S., instructor in zoology, Oberlin College. These investigations were made on Weepecket, Penikese, and Muskeget islands. Stomachs of young terns were examined, and the feeding of the young by the parent, as well as the feeding of the adult birds, was carefully noted. Mr. Jones gives the following estimate of the tern population of the various islands where they nest: Weepecket, 2,000; Penikese, 10,000; Muskeget, 80,000; total, 92,000. The two species (*Sterna hirundo* and *S. dougalli*) are represented in about the proportion of 2 to 1. The feeding habits and the food of the two are the same. The number of fishes eaten in this region by terns in the course of one day is estimated by Mr. Jones as follows: Sand launce (*Ammodytes americanus*), 736,000; chogset (*Tautogolabrus adspersus*), 73,600; mullet (*Mugil curema*), 36,800; pollock (*Pollachius virens*), 27,600; clupeid fish (*Clupea* or *Pombolobus*) 27,600, and flounder (*Pseudopleuronectes americanus*), 18,400. Mr. Jones concludes that the number of food fishes consumed by terns is a negligible quantity. The food of the gulls, loons, kingfishers, osprey, and ducks was not studied.

The bactericidal properties of sera of marine animals.—G. F. Ruediger, M. D., Memorial Institute for Infectious Diseases, Chicago (Rush Medical College). The object of this work was to find a normal blood serum in cold-blooded animals which would be destructive to streptococci. Sera from butter-fish, dog-fish, conger eel, flounder, mackerel, dusky shark, sand shark, scup, squeteague, butterfly-ray, sting-ray, common skate, squid, lobster, spider crab, king crab, snapping turtle, painted turtle, and spotted turtle were used. Streptococci were found to grow well in all of these sera, excepting those of the painted turtle and spotted turtle. These two sera seemed to kill large numbers of organisms from some cultures of streptococci, other cultures, however, not being affected. Heating the serum destroyed its bactericidal properties. An attempt was also made to immunize the dog-fish, but lack of time prevented conclusive results.

A statistical study of Fundulus majalis, with a view to the determination of selective characters.—Francis Bertody Sumner, Ph. D., instructor in zoology, College of the City of New York, and director of Woods Hole Laboratory.

In addition to this work the compilation of the catalogue of the fauna and flora of the Woods Hole region, elsewhere referred to, was conducted by Doctor Sumner, with the assistance of Mr. Raymond C. Osburn, graduate student, Columbia University, and others.

The color changes of fishes.—F. C. Carlton, graduate student, Harvard University.

Experiments upon phototactic responses of star-fish.—Grant Smith, graduate student, Harvard University.

Studies of the morphology of Hydromedusæ.—Henry Farnham Perkins, Ph. D., instructor in biology, University of Vermont.

Minute structure of the rods of the retina of fishes.—Arthur D. Howard, M. S., graduate student, Harvard University.

A study of a parasite of the oyster (Bucephalus cucullus McC.).—John Y. Graham, Ph. D., professor of biology, University of Alabama.

Collection of material for histological studies.—Ulric Dahlgren, M. S., assistant professor of histology, Princeton University.

(1) *Dimorphism in Metridium marginatum.* (2) *The blood parasites of the turtle.*—Clarence W. Hahn, A. M., graduate student, Harvard University.

The effect of heredity on the dimorphism exhibited in the optic chiasma of teleosts.—Austin P. Larrabee, A. M., graduate student, Harvard University.

The reaction of eyeless fish to light.—Joseph A. Long, graduate student, Harvard University.

Comparative study of muscular tonus.—Samual Steen Maxwell, Ph. D., instructor in physiology, Harvard Medical School.

Studies on the phosphorescence of ctenophores.—Amos W. Peters, Ph. D., instructor in physiology, University of Illinois.

Studies of the gregarines.—George G. Scott, M. A., tutor in the College of the City of New York.

Phototaxis in Copepoda.—John A. Shott, A. M., professor of biology and physics, Westminster College.

(1) *Crustacean metamorphosis.* (2) *Studies of the head and alimentary canal of Diptera.*—Millett T. Thompson, Ph. D., instructor in zoology, collegiate department, Clark University.

BEAUFORT LABORATORY (DR. CASWELL GRAVE, DIRECTOR).

At the beginning of the fiscal year the laboratory at Beaufort, N. C., had been open for over a month, and it was continued in operation until September 30; during July and August all of the rooms were occupied by investigators and student assistants. The facilities of the laboratory had been improved in the preceding fiscal year by the installation of a pumping plant, and during the summer of 1903 it was possible to keep living material for study in the laboratory and to maintain an instructive exhibit in the aquaria, where from 50 to 200 live animals, principally small and moderate sized fishes, with a few species of invertebrates, were on exhibition daily. Owing to the lack of light and aeration in the large tanks, it was found impossible to maintain an exhibit of the larger species of fishes, but plans for overcoming this difficulty are now under consideration. The laboratory

fleet has been augmented by the addition of a sharpie and two skiffs, and during the season of active operations consisted of the launch *Petrel*, the sharpie *Cero*, and 8 rowboats, all of which were in almost constant use. The *Petrel* and the *Cero* were employed in carrying on a biological survey of the waters in the vicinity of Beaufort, and in collecting materials for the use of investigators in the laboratory. The *Petrel* was also used in experiments in oyster culture carried on jointly by this Bureau and the North Carolina Geological Survey.

The oyster experiments and investigations in Pamlico Sound promise important economic results. Thirty plants have been made during the year, making a total of 35 plants in 13 localities now under the supervision of the laboratory. Progress has also been made in the collection of data relating to the status of private plants and in collating the experiences of those who have at various times attempted oyster culture in Pamlico Sound and vicinity, all of which have a bearing upon the feasibility of state encouragement of the industry. The biological survey contemplates the assembling of a museum, the collection of all possible information concerning the rich fauna in the vicinity of Beaufort, and the preparation of a catalogue and charts showing the local distribution of the various species, their time of occurrence, food, enemies, parasites, breeding habits, etc., as well as the economic status of those species which are utilized by man. During the season considerable progress has been made in this undertaking, and besides the collection, preservation, and labeling of specimens, numerous notes have been made relating to the fishes of Beaufort and adjacent waters. In addition to many species which they do not recognize, 50 species of fishes are known to the fishermen, and about 30 of these have or have had an economic value at Beaufort. Work of a similar character is being carried on with the invertebrates, and, as opportunity presents, the scope of the survey will be extended both geographically and with reference to species. It is believed that the catalogue, as it becomes more exhaustive, will furnish information of great economic and scientific value.

During recent years there has been an increase in the importance and value of the clam as a fishery product in the vicinity of Beaufort, and in recognition of this steps have been taken toward an investigation of the natural history of the species and of the economic significance of present methods of the fisheries. In May, 1903, arrangements were made to carry on experiments in clam culture jointly with certain persons industrially engaged in the business. Sufficient time has not elapsed for the attainment of any results.

The observations on the diamond-back terrapin begun in 1902 have not been actively prosecuted, as superior opportunities have been presented elsewhere for the conduct of this work by the Bureau.

During the summer of 1903 thirteen persons at the laboratory carried on special lines of investigation, which are summarized below:

The early development of an ascidian (*Cynthia* sp.) was investigated by Prof. W. K. Brooks, of Johns Hopkins University, during two weeks in September, in order to compare certain structural characters of the eggs and larvæ and certain features in the development with corresponding stages in *Salpa*.

The study of *Phoronis architecta*, begun by Mr. R. P. Cowles, of Johns Hopkins University, two years ago, was completed, and the study of the development of a species of *Ascarus* parasitic in the toadfish, also a research on the cell lineage of *Axiotheca murosa*, a species of annelid found in the vicinity of Beaufort, were taken up.

Studies of peculiar cœlenterate larvæ, which present divergences from other larval cœlenterates already described, were conducted by Mr. L. R. Cary, of Johns Hopkins University. The specimens were taken in the tow nets, and from the small actinians developed from them it appears that the species is *Paractis rapiformis*.

The effect of X-rays on the development of the chick was studied by Mr. P. K. Gilman, with results that are expected to exert influence on certain lines of surgery.

Living eggs of *Fasciolaria tulipa* and the method of ingestion by the few fertile eggs of the large number in the same capsule which never undergo development were subjects of investigation by Dr. O. C. Glaser, of Johns Hopkins University.

Studies on the breeding habits of the pipefish were continued by Mr. E. W. Gudger, of Johns Hopkins University, the method by which the female transfers her eggs to the brood pouch of the male being especially observed. Material was preserved to serve as a basis for a study of the embryology of the species.

About 275 species of insects occurring in the vicinity of Beaufort were collected by Mr. Franklin Sherman, jr., and notes were made relating to the habits, comparative abundance, and other matters concerning 32 species. Special attention was paid to species of economic importance, viz., the harlequin, cabbage bug, chinch bug, cotton louse, cabbage louse, spotted melon beetle, striped melon beetle, spotted belidnota, herbivorous lady beetle, pine weevil, potato beetle, tortoise beetles (3 species), horse-flies (3 species), apple-tree tent-caterpillar, bean-leaf beetle, house fly, large corn-stalk borer, corn-hill beetle, and blister beetle.

Collections representing 30 species of Hydromedusæ were made by Mr. Samuel Rittenhouse, of Johns Hopkins University, who also preserved material for work on the development of *Turritopsis*.

The plankton of the harbor was studied by Dr. Adolf Reichard, and material was collected for a research on the development of *Appendicularia*.

The collection of annelids at the laboratory was rearranged, labeled, and studied by Mr. Clarence A. Shore, of Johns Hopkins University, who also made additional collections whenever the tides and weather permitted, obtaining several hitherto unrepresented species and bringing the total number up to 52.

The algæ of the region were studied by Mr. W. D. Hoyt, of the University of Georgia, 54 species being collected. Notes on the structure, habitat, and reproduction characteristics of each were filed in the laboratory catalogue.

Fishes of the vicinity of Beaufort were collected by Mr. George T. Bean, a number of species obtained whose occurrence was before unknown bringing the list up to 119. Records of the food, breeding habits, and economic importance were preserved.

The study of a destructive parasite of the oyster, a trematode of the genus *Gasterostomum*, was continued by Dr. D. H. Tennent, of Johns Hopkins University, who has traced the complete life history of this worm. The adult form lives in the alimentary canal of several species of Beaufort fishes.

REPORT ON STATISTICS AND METHODS OF THE FISHERIES.

By A. B. Alexander, *Assistant in Charge.*

SUMMARY OF THE WORK.

The work of this division during 1904 included a statistical canvass of the salmon fisheries of Alaska for the years 1901, 1902, and 1903, and of the salmon-canning industry of Washington, Oregon, and California for the season of 1903; an investigation of the fisheries of the South Atlantic and Gulf States for 1902, including inquiries into the alligator and otter industries of the interior waters of Florida; a canvass of the New England fisheries and those of the interior waters of New York and Vermont for 1902; of the Hawaiian Islands for 1903, and of the shad and alewife fisheries of North Carolina for the season of 1904. At the close of the year an investigation of the Great Lakes fisheries was in progress, and a study of the fishery products on exhibition at the Louisiana Purchase Exposition had been undertaken. These inquiries were conducted through the regular corps of statistical field agents. Monthly returns of the quantity and value of the fish caught and landed at Boston and Gloucester, Mass., by American vessels have been submitted by local agents. The results of the various canvasses are summarized in the following pages, and a detailed report on the fisheries of the interior waters of New York and Vermont is in course of publication. In addition to the usual monthly bulletins of fishery products landed at Boston and Gloucester, the following have been issued by the division during the year:

No. 145. Statement of the quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American vessels during the year 1903.

No. 147. Fisheries of the Gulf States, 1902.

No. 149. Fisheries of the South Atlantic States, 1902.

No. 151. Fisheries of the New England States, 1902.

VESSEL FISHERIES OF BOSTON AND GLOUCESTER.

The quantity of fishery products landed at Boston and Gloucester, Mass., by American fishing vessels as their own catch in 1903 was 6,990 fares, consisting of 111,442,114 pounds of fresh fish, valued at $2,686,791, and 46,050,228 pounds of salted fish, valued at $1,743,240—a total of 157,492,342 pounds, valued at $4,430,031. From banks east of 66° west longitude there were 721 fares, amounting to 53,282,288 pounds, valued at $1,559,596, and from banks off the New England coast west of that meridian 6,269 fares, with 104,210,054 pounds, valued at $2,870,435. As compared with the returns for 1902 there has been a decrease of 344 fares and of 10,462,533 pounds in the total quantity of fish landed, but an increase of $50,949 in the total value. The falling off in quantity is no doubt largely due to inclement weather, which, during the winter months and to some extent in the summer, frequently detained the vessels in port and also interfered with their operations while on the fishing grounds, and the consequent scarcity of fish at various times may partly account for the increase in value. In this connection, however, it is noticed that 9,650,061 pounds of the decrease was in fish from the more distant fishing grounds—east of 66° west longitude. The trips from that region were less numerous and averaged considerably smaller than in the previous year. There was also a slight falling off in the number of trips and in the quantity of products landed from banks off the New England coast, but the average size of the fares was greater.

The receipts of fish at Boston from American fishing vessels during the year was 3,818 trips, consisting of 78,383,472 pounds of fresh fish, valued at $2,001,485, and 1,883,400 pounds of salted fish, valued at $49,642; a total of 80,266,872 pounds, with a value of $2,051,127. Of this product 224 trips, amounting to 10,470,560 pounds, valued at $289,820, were from banks east of 66° west longitude, and 3,594 trips, with 69,796,312 pounds, valued at $1,761,307, were from banks off the New England coast.

The number of trips landed at Gloucester was 3,172, having 33,058,642 pounds of fresh fish, valued at $685,306, and 44,166,828 pounds of salted fish, valued at $1,693,598; a total of 77,225,470 pounds, valued at $2,378,904. From the eastern banks there were 497 trips, with 42,811,728 pounds, valued at $1,269,776, and from banks off the New England coast 2,675 trips, with 34,413,742 pounds, valued at $1,109,128.

At Boston there was a decrease of 163 trips as compared with the preceding year, but an increase of 1,292,876 pounds in the quantity and of $8,489 in the value of the fish; and at Gloucester a decrease of 181 trips and of 11,755,409 pounds in quantity, but an increase of $42,460 in value.

Summary, by fishing grounds, of certain fishery products landed at Boston, Mass., by American fishing vessels, 1903.

Fishing grounds.	No. of trips.	Cod.				Cusk, fresh.	
		Fresh.		Salted.			
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:							
La Have Bank	84	920,000	$25,441			257,000	$4,051
Western Bank	33	567,000	16,005	52,000	$1,060	37,000	722
Green Bank	1						
Grand Bank	5						
St. Peters Bank	1	55,000	1,925				
Off Newfoundland	15						
Cape Shore	84	1,408,000	44,597			218,000	3,032
Greenland and Iceland	1						
Total	224	2,950,000	87,968	52,000	1,060	512,000	7,805
West of 66° W. longitude:							
Browns Bank	60	1,159,000	30,965	20,000	700	266,000	4,189
Georges Bank	660	5,488,500	156,794	7,000	245	241,900	3,927
Cashes Bank	39	291,500	8,843	14,000	420	137,000	2,066
Clark Bank	22	160,500	4,540			5,000	79
Fippenies Bank	4	50,000	1,425			4,000	60
Middle Bank	423	558,300	20,254			26,100	459
Platts Bank	1	5,000	175			2,000	30
Jeffreys Ledge	280	414,800	15,714			90,400	1,532
South Channel	582	4,524,600	132,223			153,300	2,412
Nantucket Shoals	68	813,200	21,521				
Off Highland Light	73	229,600	6,287			2,000	55
Off Chatham	89	370,300	11,070			10,500	193
Bay of Fundy	1	20,000	800				
Shore, general	1,292	4,346,050	123,282			223,900	3,701
Total	3,594	18,431,350	532,843	41,000	1,365	1,162,100	18,703
Grand total	3,818	21,381,350	620,811	93,000	2,425	1,674,100	26,508

Fishing grounds.	Haddock, fresh.		Hake, fresh.		Pollock, fresh.		Halibut.			
							Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:										
La Have Bank	876,500	$20,882	372,500	$5,538	57,000	$1,126	69,050	$5,580		
Western Bank	143,500	4,450	188,000	3,563	51,510	1,158	213,200	15,114		
Green Bank							20,000	1,400		
Grand Bank							107,000	6,700		
St. Peters Bank							5,000	400		
Off Newfoundland							135,000	7,150		
Cape Shore	1,199,000	32,667	456,500	7,070	122,500	1,902	14,500	1,521		
Greenland and Iceland									180,000	$14,400
Total	2,219,000	57,999	1,017,000	16,171	231,010	4,186	563,750	37,865	180,000	14,400
West of 66° W. longitude:										
Browns Bank	1,423,000	26,200	118,000	1,966	44,500	949	34,300	2,863		
Georges Bank	11,283,800	213,152	827,300	14,960	194,200	3,892	121,820	8,011		
Cashes Bank	174,600	5,395	367,000	6,193	29,600	418	1,200	98		
Clark Bank	278,200	6,686	103,000	1,637	5,000	80	1,000	70		
Fippenies Bank	12,000	468	91,000	1,065	3,000	40	300	54		
Middle Bank	2,489,100	64,278	316,700	5,425	197,300	4,736	4,000	278		
Platts Bank	1,500	45	23,000	230	1,000	10				
Jeffreys Ledge	854,050	27,265	763,500	11,453	498,400	7,700	2,800	354		
South Channel	9,392,300	255,410	4,321,500	65,027	115,900	2,058	25,700	2,824		
Nantucket Shoals	290,000	7,186	36,400	616	53,100	629	200	16		
Off Highland Light	815,800	21,472	62,800	1,204	26,900	715	3,800	430		
Off Chatham	1,201,600	32,922	179,400	3,625	47,400	1,616	2,900	388		
Bay of Fundy			4,000	120			13,000	1,300		
Shore, general	6,781,250	133,025	1,387,150	28,567	1,861,200	28,666	67,185	3,211		
Total	34,997,200	793,504	8,600,750	142,088	3,077,500	51,509	278,205	19,897		
Grand total	37,216,200	851,503	9,617,750	158,259	3,308,510	55,695	841,955	57,762	180,000	14,400

Summary, by fishing grounds, of certain fishery products landed at Boston, Mass., by American fishing vessels, 1903—Continued.

Fishing grounds.	Mackerel.				Other fish.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank	....	....	....	....	600	$36	....	....
Off Newfoundland	....	....	....	....	983,000	23,040	1,424,000	$20,300
Cape Shore	192,000	$10,435	145,200	$8,475	1,000	80	....	....
Total	192,000	10,435	145,200	8,475	984,600	23,156	1,424,000	20,300
West of 66° W. longitude:								
Georges Bank	....	....	....	....	1,244,073	92,922	....	....
Middle Bank	353,260	15,969	....	....	4,800	564	....	....
Jeffreys Ledge	9,800	882	....	....	14,966	1,443	....	....
South Channel	5,600	396	....	....	4,600	531	....	....
Shore, general	899,183	64,866	41,200	4,042	630,725	19,783	....	....
Total	1,267,843	82,113	41,200	4,042	1,899,164	115,243	....	....
Grand total	1,459,843	92,548	186,400	12,517	2,883,764	138,399	1,424,000	20,300

Fishing grounds.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:						
La Have Bank	2,552,650	$62,654	....	....	2,552,650	$62,654
Western Bank	1,200,210	41,012	52,000	$1,060	1,252,210	42,072
Green Bank	20,000	1,400	....	....	20,000	1,400
Grand Bank	107,000	6,700	....	....	107,000	6,700
St. Peters Bank	60,000	2,325	....	....	60,000	2,325
Off Newfoundland	1,118,000	30,190	1,424,000	20,300	2,542,000	50,490
Cape Shore	3,611,500	101,3[illegible]4	145,200	8,475	3,756,700	109,779
Greenland and Iceland	....	....	180,000	14,400	180,000	14,400
Total	8,669,300	245,585	1,801,200	44,235	10,470,560	289,820
West of 66° W. longitude:						
Browns Bank	3,044,800	67,132	20,000	700	3,064,800	67,832
Georges Bank	19,401,593	493,658	7,000	245	19,408,593	493,9[illegible]3
Cashes Bank	1,000,900	23,013	14,000	420	1,014,900	23,433
Clark Bank	552,700	13,092	....	....	552,700	13,092
Fippenies Bank	160,300	3,112	....	....	160,300	3,112
Middle Bank	3,949,560	111,963	....	....	3,949,560	111,963
Platts Bank	32,500	490	....	....	32,500	490
Jeffreys Ledge	2,648,716	66,343	....	....	2,648,716	66,343
South Channel	18,543,500	460,881	....	....	18,543,500	460,881
Nantucket Shoals	1,192,900	29,968	....	....	1,192,900	29,968
Off Highland Light	1,140,900	29,163	....	....	1,140,900	29,163
Off Chatham	1,812,100	49,814	....	....	1,812,100	49,814
Bay of Fundy	37,000	2,220	....	....	37,000	2,220
Shore, general	16,196,643	405,051	41,200	4,042	16,237,843	409,093
Total	69,714,112	1,755,900	82,200	5,407	69,796,312	1,761,307
Grand total	78,383,472	2,001,485	1,883,400	49,642	80,266,872	2,051,127

Summary, by fishing grounds, of certain fishery products landed at Gloucester, Mass., by American fishing vessels, 1903.

Fishing grounds.	No. of trips.	Cod.				Cusk.			
		Fresh.		Salted.		Fresh.		Salted.	
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:									
La Have Bank	125	2,967,297	$61,963	441,141	$17,312	612,796	$8,618	10,000	$250
Western Bank	34	540,465	12,324	500,400	18,992	43,000	622	4,000	130
Quereau Bank	78	1,352,484	25,006	3,459,579	111,104	35,700	497	22,000	660
Green Bank	9	10,000	200	89,400	3,478	....	......	....	......
Grand Bank	89	11,000	190	11,756,525	395,744	....	......	....	......
Bacalieu Bank	20	5,000	113	54,455	2,302	2,000	26	....	......
Off Newfoundland	57	46,000	1,035	974,330	35,387	....	......	....	......
Cape North	1	98,000	1,722	....	....	4,000	52	....	......
Cape Shore	71	376,280	6,447	158,900	5,970	160,300	2,102	....	......
Gulf of St. Lawrence	13	50,000	1,060	150,642	5,541	....	......	3,784	123
Total	497	5,456,526	110,060	17,585,372	595,825	857,796	11,917	39,784	1,163
West of 66° W. longitude:									
Browns Bank	31	719,697	13,232	74,050	2,807	170,546	2,217	....	......
Georges Bank	448	1,058,495	22,768	9,321,711	356,248	29,870	530	38,740	1,166
Cashes Bank	17	212,805	5,513	....	....	69,480	955	....	......
German Bank	1	....	......	55,000	2,325	....	......	....	......
Jeffreys Ledge	1	13,000	433	....	....	....	......	....	......
Ipswich Bay	512	304,086	6,091	....	....	....	......	....	......
South Channel	16	61,200	2,270	....	....	12,420	199	....	......
Off Chatham	2	....	......	....	....	....	......	....	......
Bay of Fundy	40	120,986	2,562	....	....	65,745	870	....	......
Shore, general	1,607	1,229,070	31,040	66,000	2,445	1,000	16	....	......
Total	2,675	3,719,839	83,909	9,516,761	363,825	849,061	4,787	38,740	1,166
Grand total	3,172	9,175,865	193,969	27,102,133	959,650	1,206,857	16,704	78,524	2,329

Fishing grounds.	Haddock.				Hake.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank	1,032,965	$15,210	....	....	2,630,430	$25,998	10,000	$263
Western Bank	145,000	2,268	....	....	220,300	1,964	4,000	90
Quereau Bank	18,000	149	....	....	95,500	1,088	31,000	790
Green Bank	....	....	....	....	....	....	4,000	90
Grand Bank	....	....	....	....	5,000	65	4,000	110
Bacalieu Bank	....	....	....	....	8,000	88	....	....
Cape North	....	....	....	....	20,000	160	....	....
Cape Shore	118,425	1,556	....	....	96,000	1,043	....	....
Total	1,314,390	19,183	....	....	3,075,230	30,406	53,000	1,343
West of 66° W. longitude:								
Browns Bank	237,220	2,565	....	....	247,060	2,050	....	....
Georges Bank	1,264,365	18,688	4,000	$90	63,810	848	25,510	531
Cashes Bank	46,120	1,021	....	....	531,213	4,837	....	....
Jeffreys Ledge	3,150	102	....	....	6,150	77	....	....
Ipswich Bay	150	2	....	....	....	....	....	....
South Channel	96,430	2,335	....	....	176,000	1,947	....	....
Bay of Fundy	2,000	16	....	....	988,480	10,526	....	....
Shore, general	158,827	4,214	....	....	63,040	739	....	....
Total	1,808,262	28,943	4,000	90	2,075,753	21,024	25,510	531
Grand total	3,122,652	48,126	4,000	90	5,150,983	51,430	78,510	1,874

Summary, by fishing grounds, of certain fishery products landed at Gloucester, Mass., by American fishing vessels, 1903—Continued.

Fishing grounds.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank	23,500	$179	5,000	$113	95,626	$7,386	16,000	$1,000
Western Bank			7,000	158	111,265	9,652	8,000	420
Quereau Bank	3,000	18	20,905	1,846	438,629	40,946	3,000	203
Green Bank					180,707	15,223		
Grand Bank					654,835	48,383	24,000	1,531
Bacalieu Bank					461,960	25,108	568,600	43,115
Off Newfoundland					140,524	10,678	24,540	1,241
Cape North	6,500	39						
Cape Shore					1,000	96		
Gulf of St. Lawrence					161,454	9,602	7,840	412
Total	33,000	236	32,905	2,117	2,246,000	167,074	651,980	47,922
West of 66° W. longitude:								
Browns Bank	2,230	10			15,639	1,498		
Georges Bank	2,800	40	100,835	2,105	518,046	39,765		
Ipswich Bay	5,393,000	39,553						
Off Chatham	158,000	632						
Bay of Fundy	7,000	49						
Shore, general	2,385,530	19,112	20,000	250				
Total	7,948,560	59,396	120,835	2,355	533,685	41,263		
Grand total	7,981,560	59,632	153,740	4,472	2,779,685	208,337	651,980	47,922

Fishing grounds.	Mackerel.				Other fish.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:								
La Have Bank					1,675	$144		
Western Bank							600	$33
Quereau Bank					4,870	485		
Bacalieu Bank					1,700	157		
Off Newfoundland					2,114,200	55,272	6,462,600	97,918
Cape Shore	60,300	$3,469	1,819,800	$103,241				
Gulf of St. Lawrence			50,000	4,188			950,000	17,623
Total	60,300	3,469	1,869,800	107,429	2,122,445	56,058	7,413,200	115,574
West of 66° W. longitude:								
Georges Bank			878,241	64,041	2,985	254		
Ipswich Bay	14,760	1,206			31,500	114	683,200	9,336
Bay of Fundy	50,400	2,080	451,600	32,349				
Shore, general	455,130	31,433	4,645,900	345,905	903,520	12,494	156,000	2,627
Total	520,290	34,719	5,975,741	442,295	938,005	12,862	839,200	11,963
Grand total	580,590	38,188	7,845,541	549,724	3,060,450	68,920	8,252,400	127,537

Fishing grounds.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude:						
La Have Bank	7,364,289	$119,498	482,141	$18,938	7,846,430	$138,436
Western Bank	1,060,030	26,830	524,000	19,823	1,584,030	46,653
Quereau Bank	1,948,183	68,189	3,536,484	114,603	5,484,667	182,792
Green Bank	190,707	15,423	93,400	3,563	284,107	18,986
Grand Bank	670,835	48,638	11,784,525	397,385	12,455,360	446,023
Bacalieu Bank	478,660	25,492	623,055	45,417	1,101,715	70,909
Off Newfoundland	2,300,724	66,985	7,461,470	134,546	9,762,194	201,531
Cape North	128,500	1,973			128,500	1,973

Summary, by fishing grounds, of certain fishery products landed at Gloucester, Mass., by American fishing vessels, 1903—Continued.

Fishing grounds.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
East of 66° W. longitude—Continued.						
Cape Shore	812,305	$14,713	1,978,700	$109,211	2,791,005	$123,924
Gulf of St. Lawrence	211,454	10,662	1,162,266	27,887	1,373,720	38,549
Total	15,165,687	398,403	27,646,041	871,373	42,811,728	1,269,776
West of 66° W. longitude:						
Browns Bank	1,392,392	21,572	74,050	2,807	1,466,442	24,379
Georges Bank	2,940,371	82,893	10,369,037	424,181	13,309,408	507,074
Cashes Bank	859,618	12,326	....	....	859,618	12,326
German Bank	....	....	55,000	2,325	55,000	2,325
Jeffreys Ledge	22,300	612	....	....	22,300	612
Ipswich Bay	5,743,496	46,966	683,200	9,336	6,426,696	56,302
South Channel	346,050	6,751	....	....	346,050	6,751
Off Chatham	158,000	632	....	....	158,000	632
Bay of Fundy	1,234,611	16,103	451,600	32,349	1,686,211	48,452
Shore, general	5,196,117	99,048	4,887,900	351,227	10,084,017	450,275
Total	17,892,955	286,903	16,520,787	822,225	34,413,742	1,109,128
Grand total	33,058,642	685,306	44,166,828	1,693,598	77,225,470	2,378,904

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1903.

Months.	Number of trips.	Cod.				Cusk.			
		Fresh.		Salted.		Fresh.		Salted.	
		Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	292	1,437,200	$45,421	....	....	42,400	$902	....	....
February	352	1,023,300	38,686	....	....	29,300	971	....	....
March	321	2,836,800	61,987	....	....	178,200	2,855	....	....
April	398	2,066,400	58,312	....	....	226,000	3,576	....	....
May	234	2,062,000	38,435	14,000	$420	230,000	3,291	....	....
June	184	1,224,400	50,013	52,000	1,060	99,500	1,707	....	....
July	321	1,802,600	56,814	....	....	90,500	1,206	....	....
August	330	2,084,050	54,861	27,000	945	36,400	591	....	....
September	325	2,968,100	67,048	....	....	246,300	3,845	....	....
October	279	1,636,500	59,700	....	....	126,600	2,174	....	....
November	451	1,352,900	54,894	....	....	254,900	3,492	....	....
December	331	887,100	34,640	....	....	114,000	1,898	....	....
Total landed at Boston	3,818	21,381,350	620,811	93,000	2,425	1,674,100	26,508	....	....
January	180	212,500	6,513	772,640	30,995	8,000	112	....	....
February	144	163,190	5,716	131,143	5,234	....	....	....	....
March	359	816,425	17,063	491,505	20,053	4,000	52	6,840	$171
April	368	1,982,512	35,451	1,332,959	45,888	56,535	830	7,000	228
May	266	1,720,212	31,861	2,036,973	74,682	353,907	4,502	18,924	616
June	190	648,577	12,412	2,347,375	76,525	177,175	2,293	9,760	274
July	298	565,225	10,549	7,512,139	224,343	64,540	839	12,000	315
August	168	656,120	12,266	1,680,798	65,232	133,430	1,835	....	....
September	170	915,363	19,386	1,574,479	62,892	171,840	2,564	....	....
October	446	417,746	10,765	2,538,657	98,165	126,245	1,898	....	....
November	438	820,865	22,671	6,118,821	231,981	100,185	1,603	22,000	660
December	145	257,130	9,316	564,644	23,660	11,000	176	2,000	65
Total landed at Gloucester	3,172	9,175,865	193,969	27,102,133	959,650	1,206,857	16,704	78,524	2,329
Grand total	6,990	30,557,215	814,780	27,195,133	962,075	2,880,957	43,212	78,524	2,329
Grounds E. of 66° W. long	721	8,406,526	198,028	17,637,372	596,885	1,369,796	19,722	39,784	1,163
Grounds W. of 66° W. long	6,269	22,150,689	616,752	9,557,761	365,190	1,511,161	23,490	38,740	1,166
Landed at Boston in 1902	3,981	23,233,900	571,415	10,000	200	1,123,965	18,272	....	....
Landed at Gloucester in 1902	3,353	13,139,416	223,899	30,238,261	864,952	660,540	6,712	21,000	431

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1903—Continued.

Months.	Haddock.				Hake.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	3,131,950	$92,203			308,550	$10,534		
February	4,656,800	102,367			221,400	9,192		
March	8,659,300	113,973			461,300	10,470		
April	3,747,600	76,238			109,600	1,899		
May	1,486,500	29,989			316,900	4,143		
June	1,236,100	49,847			574,800	13,006		
July	2,073,550	43,730			628,800	9,752		
August	1,971,550	57,702			875,800	13,247		
September	3,410,600	61,469			1,142,600	18,824		
October	2,495,900	68,676			1,447,000	23,024		
November	2,611,200	90,325			2,645,800	30,588		
December	1,735,150	64,984			885,200	13,580		
Total landed at Boston	37,216,200	851,503			9,617,750	158,259		
January	187,400	5,373			12,860	188		
February	471,805	11,243			10,000	150		
March	1,070,520	10,536			8,500	118		
April	579,172	5,207			80,270	752		
May	201,[illegible]	1,667			409,100	3,274		
June	22,220	248			1,181,953	9,691	5,000	$63
July	65,000	543			674,000	5,713		
August	42,000	269	4,000	$90	275,680	2,393	2,500	56
September	56,465	517			945,100	10,489	25,510	586
October	19,710	450			986,840	12,172		
November	204,430	4,953			505,280	5,755	34,000	873
December	202,300	7,120			61,400	735	11,500	296
Total landed at Gloucester	3,122,652	48,126	4,000	90	5,150,983	51,430	78,510	1,874
Grand total	40,338,852	899,629	4,000	90	14,768,733	209,689	78,510	1,874
Grounds E. of 66° W. long	3,533,390	77,182			4,092,230	46,577	53,000	1,343
Grounds W. of 66° W. long	36,805,462	822,447	4,000	90	10,676,503	163,112	25,510	531
Landed at Boston in 1902	34,138,850	781,099			8,223,850	141,604		
Landed at Gloucester in 1902	4,256,464	57,464	2,000	40	6,039,672	64,952	134,000	2,392

Months.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	223,900	$4,728			25,050	$2,855		
February	99,400	3,928			82,820	6,489		
March	87,700	2,375			187,800	8,356		
April	48,600	1,025			50,950	4,994		
May	98,200	1,028			38,800	2,475		
June	58,010	1,319			81,085	7,029		
July	146,600	2,897			132,100	8,236		
August	155,100	2,469			140,000	7,318		
September	245,600	4,159			27,300	2,585	180,000	$14,400
October	578,600	9,756			39,000	3,084		
November	1,122,100	13,064			20,550	2,406		
December	444,700	8,947			16,500	1,935		
Total landed at Boston	3,308,510	55,695			841,955	57,762	180,000	14,400
January	180,220	1,775	52,075	$1,173	155,775	17,804		
February			1,000	13	325,365	27,297	3,500	175
March			6,860	86	250,533	20,132	3,000	180
April					154,512	16,065		
May	588,800	2,423	20,000	250	402,086	23,283	7,235	362
June	129,230	644			276,965	24,393	25,145	1,291
July	15,000	90			403,430	24,084		
August	6,000	36	6,000	75	287,681	15,996		
September	46,000	460	11,000	220	300,826	17,534	8,000	420
October	2,758,000	20,913	19,905	1,823	66,390	6,033	583,600	44,128

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1903—Continued.

Months.	Pollock.				Halibut.			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
November	4,104,100	$30,783	6,000	$136	101,236	$9,710	19,000	$1,203
December	154,210	2,508	30,900	696	54,886	6,006	2,500	163
Total landed at Gloucester	7,981,560	59,632	153,740	4,472	2,779,685	208,337	651,980	47,922
Grand total	11,290,070	115,327	153,740	4,472	3,621,640	266,099	831,980	62,322
Grounds E. of 66° W. long	264,010	4,422	32,905	2,117	2,809,750	204,939	831,980	62,322
Grounds W. of 66° W. long	11,026,060	110,905	120,835	2,355	811,890	61,160	....	....
Landed at Boston in 1902	3,376,863	49,331	....	....	2,258,820	153,929	....	....
Landed at Gloucester in 1902	9,202,725	69,156	16,000	215	4,067,867	283,358	752,740	51,437

Months.	Mackerel.				Other fish.[a]			
	Fresh.		Salted.		Fresh.		Salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	....	....	....	....	253,000	$6,590	740,000	$10,100
February	....	....	....	....	300,000	5,700	....	....
March	....	....	....	....	230,000	5,750	....	....
April	....	....	....	....	200,000	5,000	....	....
May	....	....	....	....	....	....	....	....
June	390,788	$24,541	145,800	$8,517	....	....	....	....
July	419,915	17,076	....	....	514,098	38,633	....	....
August	464,760	36,799	....	....	657,266	44,413	....	....
September	171,420	13,078	40,600	4,000	196,650	20,775	....	....
October	12,960	1,054	....	....	2,000	360	....	....
November	....	....	....	....	8,250	153	....	....
December	....	....	....	....	522,500	11,025	684,000	10,200
Total landed at Boston	1,459,843	92,548	186,400	12,517	2,883,764	138,399	1,424,000	20,300
January	....	....	....	....	1,224,000	35,800	2,436,000	32,519
February	....	....	....	....	143,200	4,262	31,600	434
March	....	....	....	....	262,800	8,870	55,000	757
April	....	....	....	....	286,200	2,490	329,000	4,935
May	14,400	960	19,200	1,806	....	....	....	....
June	166,500	10,692	2,037,300	116,749	....	....	....	....
July	110,520	6,455	1,463,841	105,709	23,400	145	28,000	175
August	209,700	12,295	2,364,600	175,680	97,665	659	600	33
September	11,070	982	1,811,400	138,194	23,615	1,357	....	....
October	44,640	4,632	....	....	799,630	11,282	291,000	4,821
November	23,760	2,172	149,200	11,586	1,940	205	2,108,400	35,697
December	....	....	....	....	198,000	3,850	2,972,800	48,166
Total landed at Gloucester	580,590	38,188	7,845,541	549,724	3,060,450	68,920	8,252,400	127,537
Grand total	2,040,433	130,736	8,031,941	562,241	5,944,214	207,319	9,676,400	147,837
Grounds E. of 66° W. long	252,300	13,904	2,015,000	115,904	3,107,045	79,214	8,837,200	135,874
Grounds W. of 66° W. long	1,788,133	116,832	6,016,941	446,337	2,837,169	128,105	839,200	11,963
Landed at Boston in 1902	2,095,998	140,797	645,400	37,560	3,156,350	137,751	710,000	10,680
Landed at Gloucester in 1902	676,170	39,304	7,493,600	463,910	1,572,024	42,831	10,708,400	165,391

[a] Includes herring from Newfoundland, 3,097,200 pounds frozen, $78,312, and 7,886,600 pounds salted, $118,218.

Statement, by months, of quantities and values of certain fishery products landed at Boston and Gloucester, Mass., by American fishing vessels during the year 1903—Continued.

Months.	Total.				Grand total.	
	Fresh.		Salted.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
January	5,422,050	$163,233	740,000	$10,100	6,162,050	$173,333
February	6,413,020	167,333			6,413,020	167,333
March	12,641,100	205,766			12,641,100	205,766
April	6,449,150	151,044			6,449,150	151,044
May	4,232,400	79,361	14,000	420	4,246,400	79,781
June	3,664,683	147,462	197,800	9,577	3,862,483	157,039
July	5,808,163	178,344			5,808,163	178,344
August	6,384,926	217,400	27,000	945	6,411,926	218,345
September	8,408,570	191,783	220,600	18,400	8,629,170	210,183
October	6,338,560	167,828			6,338,560	167,828
November	8,015,700	194,922			8,015,700	194,922
December	4,605,150	137,009	684,000	10,200	5,289,150	147,209
Total landed at Boston	78,383,472	2,001,485	1,883,400	49,642	80,266,872	2,051,127
January	1,980,755	67,565	3,260,715	64,687	5,241,470	132,252
February	1,113,560	48,668	167,243	5,856	1,280,803	54,524
March	2,412,778	56,771	563,205	21,247	2,975,983	78,018
April	3,139,201	60,795	1,668,959	51,051	4,808,160	111,846
May	3,690,135	67,970	2,102,332	77,716	5,792,467	145,686
June	2,602,620	60,373	4,424,580	194,902	7,027,200	255,275
July	1,921,115	48,418	9,015,980	330,542	10,937,095	378,960
August	1,708,276	45,749	4,058,498	241,166	5,766,774	286,915
September	2,470,279	53,289	3,430,389	202,312	5,900,668	255,601
October	5,219,201	68,145	3,433,162	148,937	8,652,363	217,082
November	5,861,796	77,852	8,457,421	282,136	14,319,217	359,988
December	938,926	29,711	3,584,344	73,046	4,523,270	102,757
Total landed at Gloucester	33,058,642	685,306	44,166,828	1,693,598	77,225,470	2,378,904
Grand total	111,442,114	2,686,791	46,050,228	1,743,240	157,492,342	4,430,031
Grounds E. of 66° W. long	23,835,047	643,988	29,447,241	915,608	53,282,288	1,559,596
Grounds W. of 66° W. long	87,607,067	2,042,803	16,602,987	827,632	104,210,054	2,870,435
Landed at Boston in 1902	77,608,596	1,994,198	1,365,400	48,440	78,973,996	2,042,638
Landed at Gloucester in 1902	39,614,878	787,676	49,366,001	1,548,768	88,980,879	2,336,444

FISHERIES OF THE NEW ENGLAND STATES.

The number of persons employed in the coast fisheries of the New England States in 1902 was 38,879. Of these, 23,661 were fishermen and transporters and 15,218 were engaged as shoresmen in the wholesale fishery trade and in the preparation of fishery products.

The capital invested in the fisheries amounted to $19,969,031. The investment included 1,479 vessels engaged in fishing and transporting fishery products, the value of which was $3,977,066. The net tonnage was 46,543 tons and the value of the outfit was $1,792,990. The number of boats in the shore fisheries was 11,021, valued at $682,584. The fishing apparatus employed in the vessel and shore fisheries had a value of $1,305,779. The value of shore and accessory property was $7,925,887, and the cash capital employed in operating sardine canneries, menhaden factories, in the preparation of fishery products, and in the wholesale fishery trade was $4,284,725.

The quantity of products derived from the fisheries was 528,943,797 pounds, valued at $12,280,401 as they leave the hands of the fishermen; this does not include the enhancement in value as the result of canning or other methods of preparation beyond those employed by the fishermen, nor the higher price received for products handled in the wholesale fishery trade. The leading species in the New England fisheries are alewives, cod, cusk, eels, flounders, haddock, hake, pollock, halibut, herring, mackerel, menhaden, scup, shad, smelt, squeteague, swordfish, whiting or silver hake, squid, lobsters, quahogs or hard clams, soft clams, and oysters. The products of the whale fisheries are also of considerable importance.

Since 1898, the year for which the last previous canvass of these states was made, there has been an increase in the products of the fisheries of 34.43 per cent in quantity and of 26.83 per cent in value. There has also been a small increase in the number of persons employed and in the amount of capital invested.

An interesting occurrence in connection with the New England fisheries during the past year, 1903, was the shipment from Provincetown, Mass., of a cargo of 286,000 pounds of frozen squid, out of cold storage, to St. Pierre and Miquelon, for use as bait by the French fishermen in the Grand Bank cod fisheries. The vessel carrying this cargo was the steamer *Alice M. Jacobs* of Gloucester, Mass., commanded by Capt. Solomon Jacobs, of that port. The voyage was successfully made, and the fish met with a ready sale on reaching St. Pierre. The Gloucester Daily Times, of March 25, 1903, refers to the incident as follows:

> After loading the squid at Provincetown, the steamer sailed from there two weeks ago Wednesday and reached St. Pierre the following Saturday. To avoid the ice, Captain Jacobs went to the southward of Sable Island, and St. Pierre bore 130 miles north-northeast before he shaped his course for it.
>
> On reaching that port he had no trouble in disposing of his cargo, the French bankers coming alongside and taking their baiting, although they had not yet fitted out. All were disposed of in this way except 20,000 pounds, which were put in cold storage, as Captain Jacobs was anxious to get away and home to fit for seining.
>
> Captain Jacobs says the fishermen were pleased with the squid and wanted him to return in about three weeks with a cargo of herring, for which they were willing to pay a big price.

FISHERIES OF THE SOUTH ATLANTIC STATES.

In the South Atlantic States, namely, North Carolina, South Carolina, Georgia, and the east coast of Florida, the number of persons engaged in the coast fisheries in 1902 was 23,452. There were 17,711 fishermen on vessels and boats, and 5,741 shoresmen employed in the various branches of industry dependent on the fisheries.

The total amount of capital invested was $2,991,149; the number of vessels employed was 526, valued at $392,661; the value of their outfit

was $85,095, and their net tonnage was 5,740 tons; the number of boats engaged in the shore fisheries was 9,714, valued at $349,770; the value of the fishing apparatus used on vessels and boats was $691,728, of shore and accessory property $833,395, and the amount of cash capital utilized in the wholesale fishery trade was $638,500. The principal forms of fishing apparatus were seines, gill nets, pound nets, oyster dredges and tongs.

The products of the fisheries aggregated 106,446,072 pounds, having a value to the fishermen of $2,839,633. The more abundant species were alewives, catfish, croakers, menhaden, mullet, shad, Spanish mackerel, squeteague, striped bass, hard clams, oysters, and shrimp. Black bass, blue-fish, and many other species are also taken in large quantities.

The increase in the fisheries of this section in 1902 as compared with the returns for 1897 was 36.46 per cent in the number of persons employed, 63.55 per cent in the capital invested, and 54.90 per cent in the value of the products. There was also a large increase in all important respects as far as shown by statistics available for earlier years.

FISHERIES OF THE GULF STATES.

The coast fisheries of the states bordering the Gulf of Mexico gave employment in 1902 to 18,029 persons, of whom 12,901 were engaged as fishermen in the vessel and shore fisheries, including the crews of vessels engaged in transporting fishery products, and 5,128 as shoresmen in connection with the fisheries and wholesale fishery trade.

The amount of capital invested was $4,707,460. This included 714 fishing and transporting vessels, with a net tonnage of 9,221 tons, valued with their outfits at $1,295,845; 7,102 boats in the shore fisheries, valued at $707,129; fishing apparatus used on vessels and boats, having a value of $198,414; shore and accessory property, valued at $1,586,672, and cash capital utilized in the wholesale fishery trade, amounting to $919,400. The more important forms of apparatus of capture were seines, gill nets, trammel nets, stop nets, lines, oyster dredges and tongs. The stop net, it may be explained, is a long piece of netting stretched across a stream or creek to prevent the fish that have entered from escaping when the tide recedes.

The yield of the fisheries in 1902 was 113,696,970 pounds of products, with a value to the fishermen of $3,494,196. The species secured in largest quantities were buffalo-fish, cat-fish, channel bass or red-fish, red snappers, groupers, mullet, sheepshead, Spanish mackerel, trout or squeteague, hard crabs, oysters, and shrimp.

Since 1897, the year for which they were last canvassed, the fisheries of the Gulf States have increased 29.08 per cent in the number of persons employed, 82.17 per cent in the amount of capital invested, 73.95 per cent in the quantity, and 53.81 per cent in the value of the prod-

ucts. The species in which the largest increase in yield has occurred are buffalo-fish, mullet, red snappers, groupers, oysters, and shrimp.

FISHERIES OF THE INTERIOR WATERS OF FLORIDA.

For many years an important alligator and otter industry has been prosecuted in what is generally known as the Kissimmee and Apopka regions of Florida. During the last few years the catching of fish has also been taken up in this section, and it was decided to investigate these fisheries while canvassing the coastal waters of the State. Lakes Apopka, Harris, Griffin, Eustis, Dora, Tohopekaliga, Kissimmee, Cypress, and Hatcheneha, and the Kissimmee River were visited, and the tables following show the extent of the industry for 1902. As a number of the lakes are connected with each other by short rivers, and the fishermen move from one to the other frequently, it is impossible in every case to show separately the fisheries of each lake.

Fishing first began in the Kissimmee region in 1900, and has attained considerable importance. During October, November, and December, seines are used; trot lines are operated during the rest of the year. The town of Kissimmee is the shipping point for the fishermen of this region. The same method is followed in Lake Apopka, Winter Garden and Oakland being the fishing centers. In lakes Harris, Griffin, Eustis, and Dora trot lines only are employed.

Alligators are hunted with guns, and otters are taken in traps in the Kissimmee region, the same persons generally prosecuting both industries. The hides and skins are brought to the nearest railroad towns and exchanged with the merchants for supplies.

Yield, by species, of the fisheries of the interior waters of Florida in 1902.

Species.	Lakes Harris, Griffin, Eustis, and Dora.		Lakes Tohopekaliga, Kissimmee, Cypress, and Hatcheneha, and Kissimmee River.		Lake Apopka.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass			4,940	$247	15,800	$277	20,740	$524
Bream					19,100	334	19,100	334
Cat-fish	225,000	$4,500	160,600	7,030	390,000	6,825	775,600	18,355
Crappie			13,000	380			13,000	380
Pike			1,000	50			1,000	50
Alligator hides			11,752	2,350			11,752	2,350
Otter skins			2,592	9,720			2,592	9,720
Total	225,000	4,500	193,884	19,777	424,900	7,436	843,784	31,713

Yield of the fisheries of the interior waters of Florida in 1902, shown by apparatus and species.

Apparatus and species.	Lakes Harris, Griffin, Eustis, and Dora.		Lakes Tohopekaliga, Kissimmee, Cypress, and Hatcheneha, and Kissimmee River.		Lake Apopka.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:								
Black bass	....	....	2,200	$110	11,500	$202	13,700	$312
Bream	....	....	....	....	17,100	299	17,100	299
Cat-fish	....	....	82,800	3,140	350,000	6,125	432,800	9,265
Crappie	....	....	6,600	198	....	....	6,600	198
Pike	....	....	1,000	50	....	....	1,000	50
Total	....	....	92,600	3,498	378,600	6,626	471,200	10,124
Hand lines:								
Black bass	....	....	2,740	137	....	....	2,740	137
Cat-fish	....	....	2,000	100	....	....	2,000	100
Crappie	....	....	6,400	182	....	....	6,400	182
Total	....	....	11,140	419	....	....	11,140	419
Trot lines:								
Black bass	....	....	....	....	4,300	75	4,300	75
Bream	....	....	....	....	2,000	35	2,000	35
Cat-fish	225,000	$4,500	75,800	3,790	40,000	700	340,800	8,990
Total	225,000	4,500	75,800	3,790	46,300	810	347,100	9,100
Guns:								
Alligator hides	....	....	11,752	2,350	....	....	11,752	2,350
Otter traps:								
Otter skins	....	....	2,592	9,720	....	....	2,592	9,720
Grand total	225,000	4,500	193,884	19,777	424,900	7,436	843,784	31,713

Number of persons employed in the fisheries of the interior waters of Florida in 1902.

Waters.	Fishermen.	Shoremen.	Total.
Lakes Harris, Griffin, Eustis, and Dora	30	....	30
Lakes Tohopekaliga, Kissimmee, Cypress, and Hatcheneha, and Kissimmee River	172	4	176
Lake Apopka	79	10	89
Total	281	14	295

Boats, apparatus, and shore property employed in the fisheries of the interior waters of Florida in 1902.

Items.	Lakes Harris, Griffin, Eustis, and Dora.		Lakes Tohopekaliga, Kissimmee, Cypress, and Hatcheneha, and Kissimmee River.		Lake Apopka.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Boats	30	$300	152	$2,840	56	$1,120	238	$4,260
Apparatus:								
Seines	....	....	20	1,800	23	3,450	a 43	5,250
Hand lines	....	....	....	8	....	....	....	8
Trot lines ....yds..	30,000	250	5,250	54	3,500	35	38,750	339
Guns	....	....	112	2,240	....	....	112	2,240
Otter traps	....	....	930	605	....	....	930	605
Shore and accessory property	....	450	....	300	....	450	....	1,200
Total	....	1,000	....	7,847	....	5,055	....	13,902

a Total length of seines, 20,500 yards.

FISHERIES OF THE HAWAIIAN ISLANDS.

The commercial fisheries of the Hawaiian Islands were investigated in the early part of 1904, all of the larger inhabited islands being visited and the work continuing for about two months. The purpose of the canvass was to collect statistics for the year 1903, and also to note any changes that might have occurred in the methods or otherwise in connection with the fisheries since the first investigation in 1900. There were 2,345 persons engaged in the industry in 1900, while in 1903 there were 3,241, a gain of 896; a large percentage of these was Japanese, whose numbers have increased from 485 to 1,571 during that interval. In 1900 the total investment amounted to $272,591, while in 1903 it was $309,217, a gain of $36,626. The total catch in 1900 was 6,222,455 pounds, valued at $1,083,646, while in 1903 it was 6,972,735 pounds, valued at $677,897, a gain of 750,280 pounds, but a loss of $405,749. The principal increases were in the aku, akule, aweoweo, gold-fish, hapuupuu, kumu, laenihi, moi, opelu, weke, and papai fisheries. The principal decreases appear in the amaama (mullet), hauliuli, kawakawa, kole, malolo (flying-fish), moano, oio, uku, ulua, opihi (limpet), and ula (crawfish) fisheries. The decrease in the malolo fishery is especially noteworthy. In 1900, 573,082 pounds of malolo, valued at $145,085, were secured, while in 1903 the catch amounted to 36,175 pounds, worth $3,678, a decrease of 536,907 pounds and $139,407. The natives are the only fishermen engaged in catching malolo, and in 1903 they made but little effort.

Commercial fishing is carried on from the islands of Hawaii, Kauai, Kahoolawe, Lanai, Maui, Molokai, Nihau, and Oahu, the list being increased since the last inquiry by the addition of Kahoolawe, for which no fisheries were reported in 1900. The fishermen from these islands visit certain other small and uninhabited members of the group, but the catch has been credited to the islands on which the fishermen live. The Japanese are rapidly acquiring control of the fisheries and fish trade, and on certain islands are now able to fix prices at almost any figure they wish, which explains the high price at the markets. The fish ponds on Oahu, however, where they are most numerous, are monopolized by the Chinese, who control the prices for amaama (mullet), the principal fish food for the white portion of the population.

An unfortunate feature of the fisheries of certain islands, notably Maui, Molokai, and Kaui, is the absence of inspection of the fish as landed. During the last half of 1903 there were inspectors at Wailuku and Lahaina, on the island of Maui, but for financial reasons their services were dispensed with on January 1, 1904, and there is now no inspection at those important points. Fish become tainted very quickly in such a warm climate, and the Japanese, unless they are watched closely, dispose of such with the fresh ones.

Although it was so recently as 1899 that the first lot of frogs was introduced on the island of Hawaii, they have increased so rapidly around Hilo that many are now shipped to San Francisco, and the Honolulu market is also supplied from this section. This industry has not been so successful on the other islands, however.

One of the most peculiar features of the Hawaiian fisheries has been the well-developed principle of private ownership of fishes found in the open sea and bays to within a certain prescribed distance from shore. This being contrary to American practice, the enabling act which admitted the islands as a territory in 1900 provided for the extinguishment of these rights on June 14, 1903, and fixed the manner of adjudication in the courts. In the lower courts the claims of the fishery owners were denied, it being decided that their fisheries did not constitute a vested right. One case, however, in which the fishery right was specifically mentioned in the original grant, was appealed to the United States Supreme Court, which in April of this year (1904) rendered a decision sustaining the claim. This decision will doubtless settle the status of all similar claims pending. There are a number of claims, however, in which the fishery is not specifically mentioned in the original grants, and these will doubtless have to be passed upon by the Supreme Court eventually.

FISHERIES OF THE INTERIOR LAKES AND STREAMS OF NEW YORK AND VERMONT.

A canvass of the commercial fisheries of this region was made in the fall of 1903, and the industry was found to be carried on in the following waters: Lakes Bear, Cassadaga, Canandaigua, Cayuga, Champlain, Chautauqua, Conesus, George, Keuka, Mill Site, Oneida, Onondaga, Otsego, Owasco, Seneca, and Skaneateles, and the Oneida and Seneca rivers in New York and Lake Champlain in Vermont. A few other lakes and streams were visited in both States, but as they have no commercial fisheries they are not enumerated.

The only other canvass of this region made by the Bureau was in 1896, when data were collected for the calendar year 1895. A comparison of the figures for the two years shows a most gratifying increase in every particular. In New York in 1895 the number of fishermen was 543, while in 1902 there were 804, a gain of 261. The total investment in 1895 was $19,745. In 1902 it had increased to $25,291, a gain of $5,546. In 1895 the total catch was 754,730 pounds, valued at $60,086, while in 1902 it was 1,530,918 pounds, valued at $87,897, a gain of 776,168 pounds and $27,811. The interior waters of this State produce more muskellunge and smelt than the fresh waters of any other state in the Union, while they lead all other waters, except the Great Lakes, in the catch of bullheads, pickerel, wall-eyed pike, yellow perch, and suckers.

In Vermont a most gratifying increase is shown so far as apparatus and shore and accessory property are concerned. The catch increased from 298,139 pounds, valued at $7,160 in 1895, to 542,812 pounds, worth $37,669 in 1902, a gain of 244,673 pounds and $30,509. These figures represent the fisheries in that portion of Lake Champlain lying within the state of Vermont. On the New York side no netting is permitted, but Vermont allows it during certain seasons of the year. Missisquoi Bay, at the foot of the lake, is the principal net-fishing region, and in the spring a number of seines are hauled here and in adjacent sections of the lake, for wall-eyed pike mainly; in the fall they are hauled principally for white-fish, locally known as "shad." Many attempts have been made to stop this form of fishing, which is exceedingly destructive to some of the most valuable species in the lake, more particularly wall-eyed pike, white-fish, and pickerel, which form nearly half of the catch, but it seems impossible to do so while Canada permits her fishermen to haul seines in that part of the bay which lies within her borders.

In 1902 the State of Vermont granted 5 gill-net licenses to take white-fish in Lake Bomoseen, 2 for Lake St. Catherine, 1 for Lake Memphremagog, and 1 for Lake Hortonia, and these nets captured 3,462 white-fish in Lake Bomoseen, 543 in Lake St. Catherine, 105 in Lake Memphremagog, and 165 in Lake Hortonia. A very few perch, pickerel, and sun-fish were also taken in the nets. The fishery can hardly be called commercial, as most of the fish caught were consumed by the fishermen.

The greatest drawback to the fisheries of many of the lakes and streams is the presence of undesirable species. The alewife in Seneca Lake and the ling and carp in most of the waters are very objectionable. The alewife and ling are not used for food. The carp, if taken in the winter and shipped alive to New York City, would net the shipper a fair price, being a very hardy fish, which would stand shipment in ice and arrive in good condition.

THE PACIFIC COAST COD FISHERY.

The last canvass of the cod fisheries of the Pacific coast supplied data for the year 1899. In that year there were taken in Alaskan waters and landed at San Francisco 5,917,131 pounds of salted cod, of $178,054 value. In 1903 there were landed at San Francisco 19 cargoes of cod, amounting to 2,022,300 fish in number, or approximately 9,605,925 pounds, of $288,177 value. Of this number, 170,000 fish were caught in Okhotsk Sea, 867,300 in Bering Sea, and 985,000 at the various stations among the Shumagin Islands. The Pirate Cove station is credited with 525,000 fish, Unga station with 224,000, and Sanak and Dora Harbor stations with 236,000. There were employed

in the fishery 13 vessels, carrying 167 men and 52 boys. The stations employed 86 men.

A few years ago a number of the cod stations were closed and held in reserve, being considered too expensive to operate, and, besides, the fish on adjacent grounds were said to be growing scarce. Since that time these stations have been reopened and a few others have been established, but it is now claimed that cod are becoming scarce on the grounds in the vicinity of Pirate Cove as compared with former years, and the closing of the station for a year or two is being considered. The station situated near the southern entrance of False Pass, suspended for a number of years, was operated in the season of 1903.

It is learned that fishing on Slime Bank, at one time a most prolific source, has been practically abandoned, because, according to fishermen, this ground has been "fished out." Port Moller and banks lying farther to the eastward are now the scene of operations.

Previous to 1892 the cod fishery of the Pacific coast was conducted from San Francisco. In that year Capt. J. A. Matherson, of Anacortes, Wash., formerly of Provincetown, Mass., fitted out the schooner *Lizzie Colby* for a cod-fishing trip to the Bering Sea, and, the first voyage proving a success, since that time has made annual trips to that region. Up to 1903, however, when she landed at Anacortes 360,000 pounds of cod, valued at $10,800, this vessel was the only one on Puget Sound engaged in the cod fishery. In that year two other vessels fitted out at Seattle for Alaska, returning with about 400,000 pounds of fish. One of these vessels obtained her fare in Bering Sea, the other in the vicinity of Sanak Island. Another company has recently been formed, with headquarters at Anacortes, and has a fleet of four vessels. It is expected that some of these will fish in Bering Sea during the season of 1904.

It will thus be seen that the cod fishery of the Pacific coast is rapidly growing. The method of preparing the salted product is practically the same as that followed on the Atlantic coast, the fish undergoing about the same kind of treatment. The artificial drying of cod is carried on to some extent at San Francisco, machines for that purpose having recently been introduced. From the fact that new firms are being established along the coast, it may be inferred that there is an increase in the demand for the Pacific cod.

THE HALIBUT FISHERY OF THE PACIFIC COAST.

In 1887 the halibut fishery of the Pacific coast began to attract the attention of New England fishermen, and soon afterwards a number of vessels from Gloucester, Mass., started around Cape Horn for Puget Sound. On reaching their destination they fitted out at Seattle and Port Townsend for the unexplored fishing grounds of southeast Alaska and British Columbia. Several trips of fletched halibut were secured,

but there being no market for the product on the Pacific coast, the fares were shipped overland to Boston and Gloucester. The cost of transportation, however, rendered this enterprise unremunerative, and the fresh halibut fishery also, since the local demand was limited and a large portion of the product had to find market in the East, was for a time unprofitable; but, Atlantic halibut becoming scarce, the demand for the Pacific coast product increased to such an extent that eastern firms were attracted to Puget Sound and British Columbia, and in the last ten years this branch of the fisheries has greatly increased in importance.

In the early years the fleet of small boats, sloops, and schooners engaged in catching halibut on the local banks—Cape Flattery, Cape Scott, and around San Juan Islands—landed its fish at Port Townsend, but since 1888 Seattle, owing to its superior shipping facilities, has become the business center.

While the sailing vessels comprised in the halibut fleet of Seattle do not compare in size with those of the Atlantic coast, they answer every purpose for which they were designed, many of them having fine lines, and being built to encounter rough weather. The large vessels first employed were found to be expensive, and, moreover, the shortest route to most of the halibut banks being through the narrow channels and passages between the islands and mainland of British Columbia, smaller vessels were found better suited to the purpose. It was soon recognized that the route leading to the fishing grounds of the North could be better navigated by steam than by sail power, but it was not until about eight years ago that steam vessels were adopted. At various times individual enterprises with steam vessels have been undertaken, only to be abandoned after a season or two; but the forming of the company at Vancouver, backed by eastern fishing firms, gave the halibut industry a new impetus.

Steamers were at first chartered by the company, but as the industry maintained a steady increase it was deemed advisable to have vessels especially built for its needs. The steamer *New England* was launched at Camden, N. J., in 1897, and was brought around Cape Horn to Vancouver. In 1902 the steamer *Kingfisher*, built at San Francisco, was added to the fleet. The steamer *Saga*, of Vancouver, now owned by the New England Fish Company, has also been converted into a halibut vessel, and is to make regular trips to the banks.

The fresh halibut fishery of the Pacific coast was canvassed in 1900 for the year 1899. In that year there were landed at the various points on Puget Sound 3,439,640 pounds of halibut, having a value of $108,170. In 1902, according to the Pacific Fisherman for April, 1903, there were landed in the State of Washington alone 20,050,000 pounds. Reckoning 2 cents a pound as an average price received by the fishermen, this quantity of fish would represent a little over

$400,000 in value. The number of pounds given, however, probably includes the catch for that year landed at Vancouver, which was not included in reports of the last canvass. In the same year 5,019,000 pounds of halibut were shipped from Vancouver to Boston, leaving 15,031,000 pounds to be disposed of at Seattle, Tacoma, and other points on Puget Sound. Some remarkable catches have been reported for 1903, the steamer *New England* being said to have obtained a fare of 145,000 pounds of halibut in one day's fishing, the greatest amount ever taken in one day by a vessel carrying 12 dories.

In 1903 the halibut fleet of Seattle numbered thirty-odd sailing vessels, mostly schooners, and one steamer. The schooners are small, ranging from 8 to 42 tons; the steamer *Rainier*, lost in November, was 109 tons register. Besides this fleet there were two other steamers, the *New England* and the *Kingfisher*, 71 and 141 tons, respectively, that sailed out of Vancouver, British Columbia, and as these vessels are owned by the New England Fish Company, they should be included in the American fleet. Their catch is landed at Vancouver and shipped overland in bond to Boston, where it is reshipped to various points in the West and to cities along the Atlantic seaboard.

Considerable investigation has been made at different times by fishing vessels with the object of discovering new halibut grounds, but little has been learned in recent years to indicate the existence of extensive banks offshore. The principal grounds lie, for the most part, in waters belonging to British Columbia. Large fares have been taken in Dixon Entrance, off Cape Muzon and Cape Chacon, and many trips have been secured farther north in the channels and bays of southeast Alaska, but the largest catches have been made in waters adjacent to the northern end of Queen Charlotte Islands and on banks on the east side of Hecate Strait. During the winters for the past ten years a few small steamers and an occasional schooner have been engaged in catching halibut in southeast Alaska and shipping them to Puget Sound. It may be stated that the halibut grounds in this region are not so large and prolific as those farther south.

THE SAN FRANCISCO WHALING FLEET.

The fleet of whale vessels having headquarters at San Francisco, Cal., in 1903 comprised 10 steamers, 6 barks, and 4 schooners, a total of 20 vessels, of which number 2 steamers and 4 barks were owned at New Bedford, Mass. The number of whales captured during the year was 169, of which 19 were bowhead, 5 right, and 145 sperm. These were all secured by 14 vessels, the remainder of the fleet being reported without any catch. The whale products landed at San Francisco consisted of 59,750 pounds of whalebone, 20,601 gallons of whale oil, and

179,770 gallons of sperm oil. This included 23,000 pounds of whalebone obtained from 12 whales caught in 1902 which did not arrive in San Francisco until 1903. The approximate value of whalebone was $5 a pound; of whale oil, 38 cents a gallon, and of sperm oil, 55 cents a gallon.

The portion of the above catch taken by the 6 New Bedford vessels in the fleet was 1 bowhead, 1 right, and 136 sperm whales, yielding 2,700 pounds of bowhead whalebone, 1,100 pounds of right whalebone, 7,330 gallons of whale oil, and 169,911 gallons of sperm oil.

THE SALMON-CANNING INDUSTRY OF THE PACIFIC COAST.

Washington.—It was not expected that the salmon pack on Puget Sound in 1903 would reach the unusual figures of 1901—919,953 cases, representing a value of $3,957,334; in 1902 the same region yielded 450,424 cases, valued at $1,290,951, a shrinkage of 469,529 cases and $2,666,383. But at no time in the past ten years have these fisheries been so disappointing as in 1903. There was not a large run of sockeye salmon at any time during the year. In the early part of the season the canneries began operating on a small scale, but fully expecting a large run of fish later. As the season advanced, however, the prospect grew less. Only a few of the small canneries obtained full packs; those with a capacity for a pack of 150,000 cases put up less than half that amount. Frequently during the season reliable reports were circulated that large schools of fish had been seen off Cape Flattery, Barclay Sound, and in the mouth of the Straits of Juan de Fuca, all of which led fishermen and cannerymen to believe that there would be a large fall run, but the fish that were expected did not appear, and by the middle of August the season was considered a failure.

The entire output of sockeye salmon was 159,307 cases, 127,571 cases less than were packed in 1902. The total output of all species in this region in 1903 was 455,393 cases. The total pack for the state, including the coast rivers and the Washington side of the Columbia River, was 569,036 cases, valued at $2,058,443. The pack for the same territory in 1902 was 642,370 cases and in 1901 1,081,548 cases, respectively.

The quality of chinook salmon was said to be much better than in any past season, the fish being larger and of better color, and the percentage of white-meated fish less than is usually found. The output was 119,777 cases, valued at $537,997, only 18,413 cases of which were packed on Puget Sound, a large portion of the catch being utilized fresh, mild cured, and placed in cold storage. There were mild cured 575,000 pounds of chinook salmon, and 660,000 pounds of other species placed in cold storage, valued at $66,650. The combined value of canned product, mild cured, and frozen salmon for the state amounted to $2,125,093.

In the state of Washington 28 canneries were operated, valued at $1,296,000, and giving employment to 8,687 persons. There were employed 1,437 gill nets, value $189,308; 57 drag seines and 70 purse seines, value $52,100; 656 traps (pound nets), value $1,058,293, and 29 fish wheels, value $29,000. In connection with the fishery there were also used 67 steamers and launches having a value of nearly $350,000; 154 seine boats, 270 Columbia River boats, 314 dories and skiffs, 359 scows, 32 pile drivers, and 4 sailboats, valued at $366,393. The total amount of capital invested was $3,341,094.

Oregon.—The run of salmon on the Columbia River in 1903 was unlike any previously known to the fishermen. In April, when the season opened, there was a considerable body of chinooks in the river, but in a comparatively short time they became scarce. Up to this time only a small portion of the gill nets, seines, and traps had been employed, and it was not until the season had become well advanced that it was thought advisable to bring all the fishing gear into use. At the end of June, 1902, the pack amounted to 123,000 cases; at the same time in 1903 the output was about 50,000 cases, a most remarkable decrease.

From time to time large schools of salmon were reported off the mouth of the Columbia and along the coast of Oregon. These fish were daily expected to enter the river, but instead only scattering small schools appeared in July, lasting but a few days. During this time the outlook, even for an average pack, was not encouraging, and there was considerable speculation as to the advisability of artificial propagation. Many who had hitherto looked upon it with considerable favor now seriously questioned this method of keeping up the supply, and the possibility of restoring the salmon fisheries of the Columbia River to their former importance by this means was considered extremely doubtful. The skepticism was suddenly checked, however, by the most phenomenal run of salmon ever witnessed on the Columbia River. The immense school of fish frequently reported off the coast made its appearance July 31 at Baker Bay, the traps in that vicinity being crowded to their fullest capacity. As the school advanced traps farther up the river also became crowded. The gill-netters began to take more fish than they knew what to do with, and the combined catch of traps and gill nets was more than the canneries and cold-storage plants could handle, the result being that nearly as many fish were thrown away as were utilized. So great was the stench rising from decomposed fish washed upon the beaches at Astoria that the city authorities were obliged to take steps to remove the nuisance.

The following is an extract from the Pacific Fisherman:

The average duration of a run of salmon in the Columbia has been three or four days, but in this instance there appeared to be a solid body of fish enter the river of magnitude never before equalled. As in other fishing centers there is always a tale

of some former year when the run was greatest, but this year all the old fishermen acknowledged it to surpass all that they had seen or have ever heard of, and even now, more than two weeks after the season has closed, the river is known to be full of fish hunting around for their natural spawning grounds. The character of the fish was equally as remarkable as its size, considering how late in the season it arrived. In years gone by the June run, which came late in June or early in July, was considered the best fish for commercial purposes in color and richness, but this run did not appear, but in its place the great run, fully four weeks later, and it was in fact the "June" run, as the appearance and quality of the fish were identical.

Salmon continued to arrive in a solid body until August 15, the beginning of the close season. During these fifteen days a pack of over 191,000 cases was made—over half the entire output of the river for the season—and fishermen, cannery employees, and all others connected with the fishery worked almost unceasingly, resting only a few hours at a time. At the close of the season there were few men either directly or indirectly connected with the Columbia River fisheries who were not greatly interested in the artificial propagation of salmon, and who did not strongly urge its support. The consensus of opinion now is that the future abundance of salmon in this region depends almost wholly on the amount of fry liberated from the hatcheries.

Heretofore the spring run of salmon of the Columbia River has always commanded a higher price than fish taken later in the season, the meat of the early fish being of a brighter color and containing more oil than fish taken during the fall run. A change in the quality of the fall run of fish was noticed about two years ago, when a considerable number of fish were found to possess all the qualities of spring fish. In the fall of 1902 a larger percentage of this kind of fish was noticed, and from the phenomenal fall run in 1903 a large portion of the pack made was composed of salmon that could be classed as "spring fish." Many theories are advanced in explanation of the superior qualities of this run of salmon over that of past years, it being claimed by many persons that it is due to the work of the hatcheries, because only the best fish are selected for spawning purposes. Others maintain that the change in the quality of the runs is due to natural causes.

Eighteen canneries and 9 cold-storage plants were operated in Oregon in 1903, representing an approximate value of $650,000. The output of the canneries was 306,031 cases, valued at $1,558,399. The fish handled by the cold-storage plants were as follows: Chinook salmon, mild cured, 6,740,200 pounds; fishermen's price, $404,412; frozen fish, consisting mostly of silver salmon, dog salmon, and steelhead trout, 1,024,843 pounds; value, $48,079.

The number of men directly connected with canneries was 4,172. The fishing apparatus consisted of 13 traps, 35 fish wheels, 40 drag seines, and 876 gill nets, the combined value of which amounted to

$315,300. There were also employed 751 gill-net boats, 107 dories and skiffs, 74 scows, and 5 pile drivers, valued at $168,275. Connected with the fishery were 25 small steamers and launches, ranging in size from 2 to 118 tons and valued at $111,118.

In recent years the cold-storage plants have received the largest and best chinook salmon, which they bought for 5 cents per pound for fish weighing less than 25 pounds and 6 cents per pound for fish weighing 25 pounds and over; in some instances 7 cents a pound was paid for choice fish. In consequence of the advance in price paid by the cold-storage plants, the packers have not always been supplied with fish as large as desired for canning purposes, and the cannery men have found it more profitable to dispose of the especially large fish to the cold-storage plants than to can them. To protect themselves and in the future to be able to handle all grades of fish, many of the cannery firms are arranging to have cold-storage and mild-curing plants connected with their establishments. Already a few have done so, and should the demand for mild-cured and frozen salmon continue to increase as it has in the last few years, it is predicted that in a short time all the canneries on the Columbia River will be constructed for handling both frozen and mild-cured fish.

It will be noticed by referring to the accompanying tables that the pack of steelheads for Oregon in 1903 amounted to a little over 7,000 cases. This decrease in quantity was owing to the large demand for frozen fish, a large portion of the catch being utilized in this manner; the cold-storage plants handled nearly 850,000 pounds, or 12,500 cases.

At times shad are plentiful in the Columbia River, but they are chiefly taken incidentally in traps and seines. There is comparatively a small demand for this fish, and large numbers are allowed to escape, although some shipments are made to Portland and various points on Puget Sound. As an experiment, the Sanborn Cutting Company, of Astoria, recently packed 1,292 cases of shad, but so far as is known there has been little or no sale for them. The fish were prepared, packed, and cooked in the same manner as salmon, and it is believed by the packers that could a market be created for this product, an industry of considerable importance would result.

The packing of salmon bellies and tips is an experiment undertaken by the Tallant & Grant Packing Company, of Astoria. Two hundred cases of each were put up in 1903, a case holding 4 cans, the weight of each can being 12½ pounds, or 50 pounds of fish to the case. The price of a can of bellies is $2.50, or $10 a case, of the tips, $1.50 a can, or $6 a case. Only a small portion of a fish is used for this purpose, the remaining part being packed in the usual way, and it is only when salmon are scarce that they are put up in this manner. It is under-

stood that about twenty years ago a few cases of this product were put on the market, but there being no demand for it the project was soon abandoned. At the present time, however, there is considerable call for this article of food among the first-class hotels and restaurants.

California.—California ranks last in importance in the production of canned salmon, having only three canneries, two situated on the Sacramento River and one at Requa in the northern part of the state. The pack in 1903 amounted to 12,102 cases, with a value of $65,359. The pack for 1902 was 17,246 cases, with a value of $93,128, and in 1901 it was 18,309 cases, valued at $106,182. The value of the canneries and accessory property is approximately $80,000, and they gave employment to 221 men, of whom 37 were regular fishermen. Besides this number, however, many men engaged in fishing for the markets of San Francisco and Sacramento at times disposed of their catch at the canneries and cold-storage plants. The Carquinez Packing Company, on the Sacramento River, owns no boats or nets, but purchases all of its fish, and during the season of 1903 took fish from 212 fishermen. The Black Diamond Canning Company also obtained most of its fish in this manner.

The spring pack of the Carquinez Packing Company was 4,200 cases of 1-pound talls. No fall fish were packed. The Black Diamond Cannery packed 1,819 cases of spring and 2,583 cases of fall fish. The Klamath Packing Company put up 3,500 cases. The steady decrease in the annual output of the canneries on the Sacramento River is due to the fact that a considerable portion of the catch is mild-cured. In 1901 the Carquinez Packing Company utilized in this manner 252,000 pounds of salmon; in 1902, 350,000 pounds, and in 1903 539,000 pounds, representing a total value to the fishermen of $45,640 for the three years. Had this amount of fish been packed, it would have been equal to 16,779 cases, 68 pounds of raw fish being reckoned to a case. The quantity of salmon mild-cured by the Black Diamond Canning Company was 1,272,600 pounds in 1901, 1,036,800 pounds in 1902, and 1,092,200 pounds in 1903, the first value for the three years combined being approximately $148,000. Of these fish 768,800 pounds were caught in Monterey Bay and shipped to San Francisco, where they were cured and placed in cold storage.

The salmon taken in Monterey Bay are all caught by trolling, none being taken in gill nets or other forms of apparatus. It is stated by fishermen that on July 8, 1903, 1,500 fish were caught in this manner, averaging in weight 23 pounds.

Besides the mild-cured salmon prepared by the two canneries above mentioned, there were 1,733,933 pounds handled by small cold-storage plants, making a total output of 3,365,133 pounds.

Salmon output of Washington, Oregon, and California in 1903.

Species.	Number of cases.			
	1-pound talls.	1-pound flats.	½-pound flats.	Total.
Chinook salmon	285,145	64,003	24,990	374,138
Sockeye salmon	93,959	53,084	26,137	173,180
Silver salmon	106,461	19,384	15,188	141,033
Humpback salmon	166,236	8,798	1,563	176,597
Dog salmon	12,848	....	....	12,848
Steelheads	9,373	....	....	9,373
Total	674,022	145,269	67,878	887,169

Salmon pack of Washington, Oregon, and California in 1901, 1902, and 1903.

Species.	Washington.		Oregon.		California.		Total.	
	Cases.	Value.	Cases.	Value.	Cases.	Value.	Cases.	Value.
1901.								
Chinook	85,734	$332,936	171,716	$995,953	18,307	$106,182	275,757	$1,435,071
Sockeye	802,087	3,609,391	2,895	14,475	....	....	804,982	3,623,866
Silver	101,100	353,850	52,080	208,320	....	....	153,180	562,170
Humpback	33,052	99,156	....	....	....	....	33,052	99,156
Chums	58,117	145,292	14,608	43,824	....	....	72,725	189,116
Steelheads	1,458	5,832	10,525	46,313	....	....	11,983	52,142
Total	1,081,548	4,546,457	251,824	1,308,882	18,807	106,182	1,351,679	5,961,521
1902.								
Chinook	107,621	430,484	202,168	1,091.707	17,246	93,128	327,035	1,615,319
Sockeye	288,904	1,300,068	13.333	59,998	....	....	302,237	1,360,066
Silver	115,326	415,173	29,641	106,707	....	....	144,967	521,880
Humpback	9,108	18,216	....	....	....	....	9,108	18,216
Chums	119,101	285,842	14,770	35,448	....	....	133,871	321,290
Steelheads	2,310	9,240	7,828	34,443	....	....	10,138	43,683
Total	642,370	2,459,023	267,740	1,328,303	17,246	93,128	927.356	3,880,454
1903.								
Chinook	119,777	537,997	242,259	1,308,159	12,102	65,359	374,138	1,911,515
Sockeye	159,993	735,692	13,247	59,612	....	....	173,180	795,304
Silver	104,078	374,681	36,955	147,820	....	....	141,033	522,501
Humpback	176,597	388,514	....	....	....	....	176,597	388,514
Chums	6,348	11,426	6,500	11,700	....	....	12,848	23,126
Steelheads	2,303	10,133	7,070	31,108	....	....	9,373	41,241
Total	569,036	2,058,443	306,031	1,558,399	12,102	65,359	887,169	3,682,201

THE ALASKA SALMON FISHERIES.

The output of the fisheries of Alaska for 1903 compares favorably with the season of 1902. While in 1903 the pack was 290,614 cases less than the pack of the preceding year, the advance in the price of salmon caused the value to exceed that of 1902 by nearly $1,251,000, the latter year yielding 2,536,824 cases, valued at $8,498,360, while in 1903 the output was 2,246,210 cases, with a value of $9,748,799. Of this amount the Alaska Packers' Association canned 1,267,693 cases, in addition to salmon salted and placed in cold storage.

The decrease in the pack of 1903 was not wholly the result of the small run of salmon, but was in a measure due to the smaller number of canneries operated, and to the fact that many of the canneries in southeast Alaska, on account of the low price of salmon at the beginning of the season, had contracted for a smaller number of cases than they would have packed had the increased value been foreseen.

There were 64 canneries operated in 1902, 9 of these having been built that year; 2, on the other hand, suspended operations. In 1903 60 canneries were engaged in packing salmon; 3 were built that year, only 2 of which were operated, and 5 suspended operations. The number of men engaged in the salmon fisheries was 14,708 in 1902, and 13,106 in 1903, a decrease of 1,602.

The output of salted salmon in 1902 was 25,936 barrels, valued at $191,248. There were placed in cold storage and dry salted 141,600 pounds of salmon, representing a value of $5,190. In 1903 there were salted by the canneries and salteries 35,748 barrels, value $261,086. The Pacific Cold Storage Company, at Taku Harbor, placed in cold storage 17,690 pounds of king salmon, 34,087 pounds of cohoes, 72,944 pounds of dog salmon, and 12,551 pounds of steelheads. This company also dry salted for the Japan market 243,441 pounds of dog-salmon, a total of 380,713 pounds, value $11,732.

As is frequently the case in a poor season, salmon were scarce in certain localities and plentiful in others. At Karluk in 1902 the pack was 204,190 cases; in 1903 only 90,103 cases were packed by the two canneries operated there, which are owned by the Alaska Packers' Association. The Arctic Packing Company, located at Olga Bay, 80 miles distant, met with a similar experience, the output being 45,145 cases in 1902 and 25,470 in 1903. These canneries employed about the same number of men each year, and the same kind and quantity of fishing gear. At times during the season of 1903 when salmon were quite plentiful at Chignik, Cook Inlet, and Prince William Sound, hardly enough fish could be obtained at Karluk and Olga Bay to keep the canneries running.

Many theories are advanced by cannerymen and fishermen in general as to the cause of the variation in the runs of salmon in different streams. The belief is freely expressed by some that it is due to the work of artificial propagation, and that the fry liberated from the hatchery at Karluk, arriving at the spawning age, found the waters of Cook Inlet and parts of Prince William Sound better suited to their requirements than the home stream. Others attribute the scarcity to weather conditions, and a few venture to state that instead of the large runs appearing in any particular region in cycles of four years, as is the commonly accepted theory, they require a much longer time, and from one phenomenal run to another periods of eight or nine years may elapse. The erratic runs in recent years, combined with the parent-stream theory, which in a measure has been upset by the failure of the salmon from hatcheries to return to the streams where planted when expected, has set in motion a new line of thought regarding their movements. Each season brings unlooked-for conditions, and to-day there is more attention given to the study of the habits of salmon by cannerymen than ever before.

During the past four years attention has been directed to Bristol Bay as the best region in which to engage in the salmon fisheries. The cost of operating a cannery here is probably greater than in southeastern Alaska, but the higher grade of salmon packed compensates for the extra expense involved. In 1903 the pack in this region amounted to nearly 200,000 cases more than that of 1902. Here, the season being short, about five or six weeks at most, salmon must almost daily arrive in large numbers if a full pack is to be secured. A "slack spell" for any considerable length of time is likely to result in small packs, for the time lost in the early part or middle of the season is not likely to be made up later, as is the case in some other parts of Alaska, owing to uncertain weather conditions which prevent extensive fishing. The pack, moreover, must be loaded into ships, and it is very desirable that this should be done as early in the season as possible.

The Nushagak River is the most northern point in Bristol Bay where salmon have been taken for commercial purposes. During the last three years several parties have been investigating the waters of the Kuskokwim River and tributaries, and report that a large body of red salmon enter this river annually. One of the principal obstacles to the establishment of canneries on the Kuskokwim is the shallow intricate passages leading into it, which prevent large craft from entering. Ships are an indispensable adjunct to a cannery in this region, there being no other means of transportation, and until a channel for deep-draft vessels is defined the chances are that this river will not be fished to any great extent.

Several salteries have been established on Bristol Bay southwest of the Naknek and Ugashik rivers, between Port Haiden and Khudubine Island, and the owners of these salteries intend to erect canneries on the sites in the near future.

In the years 1900, 1901, and 1902 a large number of canneries were built in southeast Alaska, although as early as 1900 there were evidently as many as the streams would support. The result has been that in the last two seasons a number of establishments were obliged to close. It has been reported that the cannery belonging to the Union Packing Company, situated at Kell Bay, Kuiu Island, is to be dismantled and the machinery taken to Bristol Bay.

The demand for mild-cured and frozen salmon being great, it is possible that in the future more of this product will be furnished by Alaska. So far only two plants have been established in that territory, one at Taku Harbor and one at Ideal Cove, the north arm of the Stikine River. The plant at Ideal Cove was operated in a small way during the seasons of 1901 and 1902, but it being made unlawful to take salmon in 1903 before July 1, and the king salmon, the species desired, being obtainable mostly in May and June, this company was forced out of business. The other company, however, having a cannery, was enabled

to operate, putting up canned, mild-cured, and frozen salmon. The species utilized in the cold-storage plants were chiefly red salmon, cohoes, dog salmon, and a few steelheads.

The ruling which prohibited the taking of salmon in southeast Alaska prior to July 1 has now been set aside, and it is possible that this will encourage the erection of cold-storage plants. There are, however, only a few localities in this region where king salmon may be secured in considerable numbers, and as this fish is mostly used by cold-storage plants for mild-curing purposes, the other species not being suitable, there is room for only a limited number of establishments of this kind. The demand for frozen salmon is increasing, however, not only in European markets but throughout the United States, and should the time come when it is more profitable to freeze than to can cohoes and dog salmon, many of the canneries now idle and some of those in operation will no doubt be converted into cold-storage plants.

METHODS OF CANNING SALMON.

An interesting account of the packing of salmon on the Columbia River is given by Mr. W. A. Wilcox in the Fish Commission Report for 1896, and the subject is also briefly treated by Capt. Jefferson F. Moser in his report on the Alaska salmon industries. Since that time, however, important changes have taken place, and while the method is essentially the same on all parts of the Pacific coast, there are a few points connected with the salmon industry of Alaska which may be mentioned.

Improvements in the nature of machinery introduced in the canneries of Alaska in the last few years have made it possible to pack nearly double the former output with little if any increase in the number of men employed. Each year has brought forth some new labor-saving device, and nearly every branch of the work is now performed with the aid of machinery, which in many instances gives more efficient service than work by hand.

Probably in no year since machinery has been extensively used in salmon canneries have there been more labor-saving machines employed than in 1903. In that season four different patterns of fish cleaners were tested, all giving satisfaction. Among other inventions, several forms of automatic weighing machines were introduced, and several styles of soldering machines were used, taking the place of the chain machine so common a few years ago. There are several kinds of machines for washing cans, also several styles of topping machines. One of the latest inventions is a machine called a "stopper," for soldering the ventholes in the cans previous to making the test for hot leaks. Filling machines apparently reached a certain perfection some four years ago, since which time few improvements have been added,

but many improvements have been made in retorts, greatly facilitating the cooking of salmon, and the machinery for manufacturing can bodies and tops has also undergone a change.

When the industry was in its infancy a pack of 150 or 200 cases was considered a good day's work. Now it is not an uncommon occurrence for a cannery to turn out from 1,500 to 2,000 cases in a day, and there are several canneries that have even a greater capacity. The daily average for an Alaska cannery is from 800 to 1,000 cases for one filler, and nearly double that amount for two. A few establishments have three fillers, and one in the Bristol Bay region has six, but it is seldom that this number of machines is kept in operation at one time.

A pack of 1,000 cases a day requires a complete modern equipment and the work of only skilled hands. In the early days of the industry most of the men employed were inexperienced, and much confusion, as well as considerable waste of material, was consequently occasioned. Now, however, a large portion of the men are employed season after season, in one cannery or another, and in a well-organized establishment the same men are engaged in the same kind of work each year, thus becoming expert in their particular lines.

There are a few canneries that have not kept pace with the times in the way of machinery, and still adhere to methods long discarded by the modern plants. This lack of improvement is largely due to the want of capital, and also to the value of the stream where the canneries are situated. An establishment located at the mouth of a bay or river which will yield not over 20,000 or 25,000 cases of salmon at most in a season is under an expense too great to permit an outlay such as would be required to place it on an equal footing with others more favorably situated. It is not to be inferred, however, that the canneries less fully supplied with labor-saving machines do not put up as fine a quality of salmon as those more fully equipped; the quality and commercial value of the packs are about the same, the only difference being that the result is attained by a slight variation in method.

From the time a salmon is landed upon the wharf until cased and ready for shipment, it is handled about twenty-four times. To watch the rapid steps of the process is most interesting, particularly if the old and new methods of packing be compared.

Handling the salmon.—Scows, boats, large dories, and steamers are used in landing the catch. Formerly the fish were pitched by hand into bins near the dressing tables on the wharf when the tide was out, but this laborious method has been largely superseded by the use of an elevator built at the end of the wharf and reaching the water's edge at a slant, to be lowered or raised according to the stage of the tide. The fish are caught up by the elevator, and on reaching the top are run into the building by means of chutes leading to the various bins. At a number of canneries tracks have been laid on a slip cut through

the wharf from the upper side down an inclined plane to the water's edge, and on these small fish cars are run. At Loring a double track is built out from the cannery, forming a kind of slip into which the steamers or boats can come and discharge fish from either side.

The salmon usually remain in the bins from twenty to twenty-four hours before being dressed, at the end of which time they are in much better condition for canning than if they had been dressed immediately after being caught. The danger of canning fish that are too fresh, however, is of minor importance as compared with the tendency in the other direction.

Dressing fish.—The manner in which salmon are handled by the "butchers," or dress gang, is a remarkable development of speed and skill, acquired through long practice. In most canneries this work is performed by Chinese, although Indians are sometimes employed and also become very expert. Two men constitute a "butcher's gang." The number of gangs in a cannery is regulated by its size and capacity. From 30 to 40 salmon are placed in a row upon a long table, heads toward the operator. One man cuts off the heads, and is followed immediately by another, who removes the fins, tails, and viscera. Only one stroke of the knife is required to remove the head; eight more cuts, and the fins and tail have been taken off and the belly opened. The first process is thus completed. The offal falls through an opening in the wharf and supplies food to a large number of salmon trout, sculpins, a few cod, and frequently halibut.

From the hands of the dress gang the fish pass into cleaning tanks, where they are scaled, washed, and given a partial cleaning on the inside. Each fish passes through at least two, and frequently three of these tanks. In the second cleaning they receive the same treatment as in the first, small bits of offal, blood, and scales which were overlooked in the first cleaning being now removed. To make sure that nothing of an objectionable nature remains, they are subjected to another inspection by a third man.

A machine which practically does away with the men in the "butcher" room was invented by Mr. William Munn, of San Francisco, who is connected with the Alaska Packers' Association. It has been used in various canneries belonging to that company during the past three seasons, and is said to give much satisfaction. Another type of fish cleaner has since appeared on the market, 23 of these machines having been used in various canneries of Alaska during the season of 1903. It is stated that each means a saving of from 15 to 20 men, and that it will satisfactorily open the fish, remove the entrails, scrape the blood from the backbone, and thoroughly wash the body. More recent inventions are used in canneries on Puget Sound, and still another machine, invented by Mr. E. A. Smith, of Seattle, Wash., and used for the first time, in 1903, by the United Fish and Packing Company,

at Fairhaven, Wash., removes the head, tail, and fins, and opens and thoroughly cleans the fish ready to cut into pieces for the cans. Fish that are dressed by the cleaning machine require less inspection than those cleaned by hand.

Cutting the fish.—Having undergone examination to insure cleanliness, the fish are pitched upon a table, attached to which is a machine that cuts them into proper lengths to fit the cans. This apparatus consists of a number of knife blades semicircular in form, with the sharp part on the convex side. The blades are set in a wooden roller or axle, and so arranged that they can be set at any desired distance apart, thus cutting the salmon into lengths to fit either "talls" or "flats," as the case may be. A fish is placed under the row of knives and the handle attached is brought down with a quick stroke, which cuts the fish transversely into pieces corresponding to the number of knives. In canneries where full lines of machinery are installed, this method has given way to the rotary cutting machine, which consists of gang knives set in an iron axle or cylinder kept in motion by belt and pulley. The cylinder is attached to the top of an elevator, the same power running both. As the fish come from the third washing, they are carried to and under the revolving knives by the elevator.

In many instances the "butcher" room is situated some little distance from the main building, and the fish, after being dressed, are taken to the elevator in push carts. Some canneries have iron tracks leading to the cutting machine, and small hand cars are run for carrying the fish.

The introduction of cutting and filling machines has greatly increased the capacity of canneries; combined, they take the place of about 25 men. Formerly, after leaving the gang knives, the fish were cut into proper sizes to fit the cans by means of a long knife wielded by a Chinaman who stood at a regular butcher's block and with quick strokes cut the sections of salmon in uniform sizes. From 2 to 4 men were thus employed. The pieces were either dropped into a basket or thrown into a wooden bin.

The tail piece is rejected by the rotary cutter and falls into a chute leading away from that into which the other portions are dropped. The very large tail pieces are utilized to some extent, but by far the greater number are thrown away. If salmon were less plentiful in Alaskan waters, it is very probable than only a small part of a fish would be rejected, but the tail portion is of small value as compared to the middle and head sections, and could not very well be placed in the same can without injuring the sale of the product. If packed under a distinct and separate label, however, there seems to be no reason why the tails should not be put on the market.

Counting the fish.—Some canneries pay the fishermen a monthly salary, others pay a certain price, according to the species, for each fish

taken. Where 30 or 40 boats are engaged in fishing, the boat's account and that of the cannery do not always agree, and frequently long and heated arguments ensue. This difficulty is partially overcome by a device, consisting of two levers fastened to a rod acting on a self-recording machine, attached to the elevator that carries the fish under the rotary cutting machine, the levers hanging perpendicularly through a slot running the whole length of the elevator, and so arranged that when a fish is placed upon it and reaches a certain point, the levers are forced up, thereby causing the machine to register. On being released, the levers drop through the slots, where they remain until another fish forces them up. While this apparatus does not insure an absolutely correct count on the part of the fishermen, it acts as a great check. Daily readings from the register give the exact number of fish packed, also the number of each species.

Filling the cans.—Having passed through the cutter, the salmon are now ready to be received by the filling machine, which cuts the sections longitudinally into the required size and at the same time fills the can. The Munn filling machine is about 7 feet high, and is built at an angle. It is fed from the top into the hopper, the mouth of which is the same shape as on a hand coffee mill. The pieces of salmon fall from the mouth down a chute, and are forced by two dogs into a receptacle through which the plunger, or filler, passes. The plunger in making a stroke cuts the salmon and at the same time fills the can within a fraction of an ounce of the required weight. Generally the cans overrun in weight; occasionally a few are weighed to see whether the machine is working properly.

Cans are led to the filler from the floor above by means of a belt, attached to which are wire racks about 4 inches apart, set at an angle to prevent the salt from spilling out. When a can arrives opposite the filler it is caught by a clasp or hook and held in front of the plunger, which is immediately thrust forward through a chamber filled with salmon, cutting the fish and at the same time filling the can. When in good working order, the machine will fill from 60 to 65 cans a minute, and when running at full speed can fill as many as 80 a minute. It is quite complicated in construction, but is easily kept in repair, and fills a long-felt want in salmon canning, performing as it does the labor of from 15 to 20 men. Its average guaranteed capacity per day is 800 cases, or 38,400 cans of 1 pound each; 48,000 cans have been filled by one machine for several days in succession. On being released by the clamp the cans roll on to a long table and are picked up by a man stationed there, who strikes each one down upon a square piece of lead weighing about 10 pounds, in order to settle the contents to the bottom, and for the purpose of detecting any deficiency in weight. So expert do these men become that the slightest variation in the quantity of salmon is detected. Cans that are not up to the

standard are pushed to the opposite side of the table, where a man stands ready to supply the requisite amount of fish to fill them.

For the hand method of filling, a large pile of salmon is thrown upon a long table, making a kind of windrow in the middle from end to end. On either side are from 8 to 10 men who select and put into the cans large pieces of salmon at first, then smaller pieces to fill all vacant spaces. As the cans are filled they are pushed along the table to the can cleaners and weigher.

The supply of salmon on the table is constantly being replenished by a man whose duty it is to keep the fillers occupied. In some hand-filling canneries each man has a box at his side, and as often as it is filled he carries it to an adjoining table, where the cans are washed or wiped, as the case may be, weighed, pieces of scrap tin ("chips") put in; and the tops put on. They are then ready for the soldering machine. Canneries were in existence a long time before any improvement was made in the method of getting the cans from the filling to the weighing and capping table. At the present time, in most canneries where no filling machines are used, a revolving belt running in a wooden track about 14 inches above the table carries the filled cans to the weighing and capping table, where a man is stationed to receive them. This simple device is a great saving of labor.

Salting.—It is essential that all the cans contain the same amount of salt; otherwise hardly two cases of salmon would have the same flavor. This is an important feature, and one of the earliest things considered in salmon canning. If the eye were the judge of the amount of salt required in the cans, there would be little or no system connected with this branch of the work, consequently mechanical means must be employed.

One case of cans is salted at a single movement of the hand, thus: The workman stands in front of a table having a trough connected on the under side, into which slides a tray holding 36 or 48 cans. In the top of the table, corresponding to the number of cans, are holes arranged at equal distances apart, or in such a manner that if the table were filled with cans the center of each would be over one of the holes. On the under side is a sheet-iron plate which slides in a groove at the sides, and is worked either by a hand or foot lever. This plate is perforated with holes corresponding to those in the table above. A quantity of salt is thrown on the table, and immediately scraped off with a thin-edged board about 2 feet long and 3 inches wide, each hole being filled in the scraping, and the salt being prevented from falling through by the iron plate underneath. The lever is then pressed, moving the plate, and the salt falls into the cans below. This operation can be repeated four or five times in a minute, and one man is thus able to keep the filling machine supplied with cans.

Weighing and washing the cans.—A cannery that puts up a hand pack usually weighs each can of fish, a man being stationed at one end of the filling table for that purpose. Where filling machines are used only an occasional can is weighed. A simple device has recently been invented for weighing the cans as they leave the filler. If they contain the required amount of salmon they are carried around by the machine and landed upon a table; if a can is light in weight it is carried only half-way around and automatically forced to one side to another table.

Cans leaving the hands of the two men stationed at the filling machine are pushed along the table to the hands of 6 or 8 men or women, who remove with dry, coarse cloths the grease or other material that may have collected on the outside. Until recently, however, in many canneries this labor was performed by a rotating washing machine, consisting of an iron cap the diameter of a can, fixed to the end of a small perpendicular shaft revolving at considerable speed. Directly under the cap was an iron rest or stand on which the cans were placed one at a time; the foot pressed a lever, which carried the can to the revolving cap above. It was then forced into the cap about one-eighth of an inch, a tight-fitting flange preventing the water from getting inside. The can was set in motion by coming into contact with the revolving cap, which also sent a stream of water against the can with sufficient force to remove the grease. For a long time it was a mooted question among cannerymen whether wiping or washing was the better method. A single washer, however, performs the work of 6 or 8 men, which is a strong argument in its favor.

The use of this machine soon led to the invention of one of larger capacity. Instead of one stand, there are 10 joined, forming a circle about 18 inches in diameter. The cans are carried to the washer by a belt leading from the filling table, and each can, as it reaches the machine, is caught by one of the washers and the cap brought down over the top. Revolving rapidly as it goes, the can is carried until the machine has revolved 180 degrees, then is released and rolls out upon a table. In some canneries the grease is removed by steam applied in the same manner as the water. One of the latest improvements is cleaning the cans by a cold-air blast which strikes directly on the top edge. A set of brushes against which the cans revolve is another method.

After being washed or wiped, as the case may be, the cans pass to the farther end of the table, where a small piece of scrap tin is placed on the top of each. The pieces of tin are called "chips," and are from 1½ to 2 inches in diameter. The shape is of no particular importance so long as the pieces are large enough to cover the hole in the top of the can, or cap, as it is called. A great deal of scrap tin

which would otherwise be thrown away is utilized in this manner. The men engaged in putting in "chips" also keep a sharp lookout for cans that may be too light in weight, and occasional tests are made.

Capping.—The next step in the process is the capping, or topping, which is done by a machine set close to the end of the table previously referred to. An endless belt, composed of rectangular pieces of metal large enough for a can to rest on without falling while in motion, conveys the cans from the table to the capper. One man places the cans on the belt and another follows them along, on the watch for pieces of salmon or bones above the edge of the can. Pieces of fish, if there be any, are jammed down flush with the top, and the overhanging bones are cut off with a pair of scissors. On reaching the machine the can passes under a cap holding a top, which immediately falls upon it with just enough force to put on the top without injuring either. The can is then forced out from under the capper by the rotation of the machine, and the next capper is brought around to receive another can. The machine is supplied with tops by means of an iron chute. As the cans revolve they are carried under a crimper, situated directly opposite the capper, and while one can is being capped another is being crimped, after which it rolls out upon a belt on its side, and is taken through the acid trough and thence to the soldering machine. The capper is supposed to correspond in speed with the filler.

Soldering.—In the early days of salmon canning the tops and also all other parts of a can were soldered by hand, a long and tedious process, which has now given way to the soldering machine. This is composed of an endless chain about 6 feet long, revolving around two shafts situated at either end of an iron trough, under which the heat is supplied. In the bottom of the trough is the solder, kept at molten heat by the fire underneath. The cans are forced along the trough by the chain in contact with their sides. Between the lower part of the chain and trough is just enough room for a can to pass without jamming. The cans enter the trough at an angle, their bottoms slightly inclined, which causes the top rim to be submerged in solder, thus distributing it evenly all around the edge. This method is superior to hand work.

In passing through the trough the cans make about half a dozen revolutions, which cause the tops to become very hot, and it is to prevent them from being blown off by the pressure of the steam which quickly generates that the center hole in the top is made. The "chip" previously mentioned prevents the hole from being choked with salmon.

Before the tops are sealed the edges must be treated with a solution of muriatic acid. This is done in the same manner as the soldering; that is, by being run through an acid trough. At no time are there

less than three or four cans under the acid chain, and ten or twelve under the soldering chain. Much depends on the operator of these two machines, and only those who have had considerable experience are intrusted with this work. A watchful eye must be kept on all the cans as they pass through, to be sure that the proper amount of solder is received. With all the caution that is taken, an occasional top is blown off, and once in a while a rim will start, which necessitates repairs and a repetition of the process. Very often several cans require attention at once, although to the inexperienced eye they may be as perfect as any of the others.

The old style of soldering machine was built over a brick furnace, coal being used as fuel, and many of this type are still in use. The apparatus is 8 feet long, about 5 feet high, and 3 feet wide, however, and the amount of space required is an objection. The modern machine occupies no more space than the chain and trough of the old one; in fact, the later improvement in this style is the chain and trough minus the brick furnace. The heating apparatus is a row of kerosene blast jets (7 in number) arranged directly under the trough, the oil and air pipes running parallel. The machine can be taken apart in a short time and set up again in any part of the building.

The improved chain soldering machines, however, are rapidly being supplanted by the spiral and finger sprocket machines. These inventions are of recent date, and are said by cannery men to be superior to the old forms. The new soldering machines have greatly expedited the work in canneries, and have been the means of reducing the number of leaky cans to a minimum, also of producing results much neater in appearance.

Testing.—On leaving the soldering machine, the cans roll down a wooden chute about 40 feet long, passing under several jets of water to set the solder. Some canneries use Manula's revolving cooler, a recent invention which practically does away with the long trough leading from the soldering machine. The disk upon which the cans rest is hollow and filled with running water. After making two revolutions, the cans are forced into an inclined trough under a stream of water. At the end of the chute are stationed two men who place the cans in coolers, or crates, which are made of flat strap iron, square-shaped, and hold about 114 cans. The cooler having been filled, it is placed upon a truck and rolled aside, where the vent holes are stopped with a drop of solder. The cans are now ready for the test kettle, or bath, a wooden box filled with water kept near the boiling point by steam pipes arranged at the bottom. The coolers are hoisted into the test kettle by block and tackle attached to an overhead track, which permits the coolers to be swung to any place desired. From two to three minutes is required for the hot leak test.

This test reveals the leaks due to imperfect soldering. Two men superintend this work, and they, like all others connected with a cannery, are very skillful. The slightest leak is immediately detected and located by small bubbles issuing from the cans. The spots are marked and the cans are taken out and placed in small wooden trays, in which they are carried to the bench men, whose duty it is to mend them. Cans that have been mended are again tested as before. In large canneries, from 20 to 25 men, stationed in front of a long bench at the side of the building, are employed in mending cans. Formerly tinsmith's charcoal stoves were used for heating purposes, but these are now mostly out of use, the soldering irons being heated by kerosene fire-pots, each pot supplied with oil and air led through small tubes, the heat and air being regulated by connecting valves. Gasoline has been used as fuel to some extent.

A cooler of cans having been tested, it is hoisted out, placed on a low square truck, and another takes its place in the bath.

Cooking.—The cans are now ready for the first cooking. It is said that in the inception of the salmon industry the cooking was considered by those not initiated in the method as an art in itself, and in consequence was guarded carefully by those possessing the knowledge. In a few years, however, the method employed became common property, since which time salmon have been cooked in the main portion of the cannery instead of in a separate room under lock and key. The first cooking was done in common tubs, hence the term bathroom now applied to that part of the building where the cooking takes place. The early retorts were of wood made on the same principle as a steam box in a shipyard for steaming plank. Later, round iron kettles were substituted, these set on end, nearly one-half consisting of cover; and round crates were used for holding the cans. When a lot of salmon was to be cooked, the cover of the retort was lifted by block and tackle rigged overhead, the retort filled with crates and the cover lowered over them, the top and bottom being fastened perfectly tight by a set of screws and levers which extended all the way around. Steam was then turned on until the desired amount of heat was obtained.

The modern retort rests horizontally in a bed, the crates being rolled in on a track. The trucks which carry them hold six crates, one piled upon another, and four loaded trucks are rolled in at one time, representing on an average some 2,500 cans.

The number of retorts in a cannery is governed by its capacity; few canneries at the present time have less than four or five. In front of each retort is a turntable, on which is an iron track, the purpose of the turntables being to receive the loaded trucks which come on tracks from different parts of the building; also to facilitate the transferring of cans from one retort to another, since it is necessary

to cook the salmon twice. After the retort is filled the door is securely fastened and the steam turned on, entering at the bottom. The amount of pressure is about 6 pounds, sometimes 12 pounds, the heat 250° F. In some establishments the first cooking is continued 40 minutes, but 60 minutes is considered by most cannery men the proper time for it.

After the first cooking the crates are taken out and placed on a long table, called a "venting table," where the cans are pricked to allow the steam and superfluous water to escape. The method of pricking is to use a small mallet with a short brad in the center. From 30 to 40 cases are placed on the table, and some six or eight Chinese, with mallets in hand, go over the entire lot with great rapidity, striking each can with a quick, sharp blow. With each stroke a jet of steam and fluid issue forth, rising to the height of 3 or 4 feet. No particular spot is aimed at; usually the puncture is made from one-half to three-fourths of an inch from the center of the top, and after the pricking or venting has been done the holes are soldered up. During this process an occasional defective can is found, and these are put aside to be repaired, a can which has been mended being substituted. When all the cans have been gone over the coolers are again loaded on the trucks and rolled into the second retort, where they are subjected to the same pressure of steam and heat as in the first cooking.

It is claimed by nearly all cannerymen that if the cans were kept in the first retort long enough to complete the cooking the amount of steam generated would spoil the contents. It is understood that Mr. William Munn, superintendent of the cannery at Alitak, Kadiak Island, has successfully experimented with one cooking, but so far as known none of those fish have been placed on the market. Mr. F. A. Seufert, however, owner of a cannery at The Dalles, Oregon, has been placing on the market for the last five years salmon which have undergone but one cooking, and says that not a single case has been returned.

The same species of salmon in different localities often requires different treatment, the method to be determined by observation. As the same superintendent usually has charge of a cannery each season, all local difficulties, which for a time would be serious obstacles to a new man, are reduced to a minimum; but the different opinions advanced regarding the cooking and handling of salmon in a cannery are necessarily the result of individual experience in different regions.

Cooling.—As soon as a retort is emptied of cans it is filled with a fresh supply from the bath, and when the cannery is operated at its full capacity the bathroom men are kept very busily employed. On coming from the second retort the coolers and contents are lowered into a bath of lye, which removes from the cans all grease and other material. A slight rinsing and a few rubs with a brush over the top

of the cans finish this work, and the cans then go into the cooling room, where a stream of water is played upon them. If the weather is rainy, they are frequently put out of doors upon the wharf and there allowed to cool. During a heavy run of salmon it often happens that the cooling room is blocked, and at such times the wharf is usually resorted to. The cans are tested during the cooling process, and many are noticed which require repair; in fact, in every handling more or less defective cans are found, and with all the care exercised, there is at the end of each season a considerable number of cases that can not be labeled as being first class. These are put into separate lots and labeled according to quality.

While cooling, the top and bottom of the cans immediately commence to contract, and for several hours a sharp popping sound is heard. Here the cans are again tested, this time by tapping the tops with a small piece of iron about 6 inches long, a 12-penny nail being sometimes used. The sound conveys to the ear of the operator an unmistakable meaning as to the condition of the can. The rapidity with which this work is done is remarkable, and the cans that escape notice during the other tests are invariably found in this one.

Lacquering and labeling.—From the cooling room the cans are transferred to another part of the building, where the lacquering is done. They are piled on end from 18 to 20 tiers deep, usually covering a space 30 by 60 feet. In many large canneries double this amount of space is covered with cans to a depth of 5 or 6 feet.

The lacquering and labeling are usually done during the middle and latter part of the season, or at times when there is a "slack spell" in the run of fish. Generally two men do the lacquering. At the end of the season, however, when the cannery is being cleaned and put in order for the winter, more men are engaged in this work. Three cases of salmon are immersed at one time. The lacquer is held in a box or trough 7 feet long, 3 feet wide, and 14 inches deep. The sides and ends of the trough are made of wood, the bottom of iron rods running lengthwise 3 inches apart; a tray fits in at the top. The cans rest on the rods at an angle, and are placed to avoid contact with each other. It is necessary that they should not touch, for if thrown together in any manner the lacquer would not present a smooth surface when dry. On each end of the trough is an upright with block and tackle attached, for lowering and hoisting the tray, which is filled with cans. After being lowered into the liquid it is immediately raised to the top edge of the trough, where it remains until the cans are dry enough to handle. They are then taken to the labeling room and stacked in tiers as before. From eight to ten lacquering troughs are in operation, and as the lacquer dries very quickly the work proceeds with great rapidity.

The old method of lacquering was to dip each can separately by hand, but the process was slow as compared with the present method. A number of long boxes, each containing about a half-barrel of lacquer, with racks arranged on the side for drying cans, composed the entire apparatus.

The lacquering machine is among the most recent improvements introduced in canneries, but it has not been adopted to a very considerable extent. By its means, however, it is possible to lacquer the pack made each day, thereby saving much time at the end of the season.

The work of labeling the cans comes next. Machines have been invented to do this work, but for the most part it is done by hand, and in the following manner: From 8 to 10 men are seated in front of the row of cans, about 4 feet apart. Each man has in front of him a bunch of several hundred labels, and by bunching them on a slant, so that a small margin of the bottom one protrudes beyond the one above it, he can apply paste to the entire number with one stroke of the brush. A can is placed in the center of the label, is quickly rolled, and the label is on. The skill displayed by many of the men and women engaged in this work is remarkable. Each man places to his right the cans he labels, forming a pile of length and width equal to his unlabeled pile. When the entire lot has been labeled it has been shifted only about 4 feet. On the Columbia River and in the Puget Sound region where the canneries put up fancy brands of salmon, most of the cans are wrapped in colored tissue paper before being labeled.

It should be stated that while the labeling is going on the cans are receiving another test. Each row is gone over as on previous occasions—that is, the cans are tapped with a small piece of iron—and even at this stage an occasional faulty can is found. These, however, had not been overlooked in former tests, but defects which before were too small for observation have since developed.

Brands of salmon.—Each cannery puts up several brands of salmon—some a dozen or more. There are a number of reasons for this, one being that there is more than one quality of salmon packed from a single species; fish packed within twenty-four or thirty-six hours after being caught are superior to those that lie on the wharf or in boats four or five days. It is sometimes impossible to pack fish soon after their arrival at the cannery, and in some cases they are much older than they should be when put into the cans. Another reason is in the demand in different parts of the country and abroad. Even one lot of fish, packed in the same way, may be split into two or more brands, which are equally good. A certain brand of salmon with an established reputation is sought by merchants in certain localities to the extent of several thousand cases, and 30,000 or 40,000 cases of the same brand in another part of the country. No other brand will sell

as quickly; the same fish under another mark might lie in the storehouse uncalled for for an indefinite period. When the Alaska Packers' Association purchased a large number of the canneries in Alaska, each packing salmon under many different labels, it was necessary to retain the brands of each individual cannery in order to hold the same customers. This is true also of the Pacific Packing and Navigation Company.

After labeling, the pack is put in cases holding forty-eight 1-pound cans each. A few canneries put up 1-pound "flats," but the major portion of the Alaska salmon is packed in 1-pound "talls." Frequently the cans are labeled and cased at the same time, which work is carried on chiefly at or near the end of the season by the cannery employees, while the fishermen and crews of vessels are engaged in stripping the seines and gill nets and stowing them away, in taking up traps, hauling up and storing boats, scows, and lighters, and also in loading the ship with the pack and getting her ready for sea. The cannery machinery, also, must be taken apart, overhauled, oiled, given a coat of white lead, and put in good condition for the next season, all of which requires considerable labor. During the winter months the canneries are in charge of watchmen.

STATE ICHTHYOLOGY OF MASSACHUSETTS

BY

THEODORE GILL

STATE ICHTHYOLOGY OF MASSACHUSETTS.[a]

By Theodore Gill.

I.

The history of the ichthyology of Massachusetts has never been written, and a sketch of such appeared to me to be the best and most seasonable response I could make to the invitation to address the investigators and students assembled at the headquarters in Massachusetts of what was affectionately known for a generation as the Fish Commission, but has recently been renamed the Bureau of Fisheries. The history is an interesting and a rather remarkable one. Of course, in the time allotted for an address, only the salient features of a long history can be given, and many minor communications and even popular works relating to the ichthyology of the region in question must remain unnoticed. The room is requisite for a neglected subject. We are often curious to know something about the personality of the men whose work we consider and such information is generally difficult for the scientific student to obtain. Of several of the old and departed writers on the fishes of Massachusetts notices will be now given, and when reference is next made to their writings, perhaps it may be done with a new interest and better means of judging their work.

The history of Massachusetts ichthyology begins early in the history of the United States—earlier, even, than any settlement by English in the state. Capt. John Smith, who acquired celebrity in connection with a more southern province, having induced certain London merchants to furnish him with two vessels for exploration of the New England coast, in the spring of 1614 visited and made a sketch map of part of the coast of territory granted to the Plymouth Company. In "A Description of New England", published in 1616, he enumerated the fishes. Excluding the "whales, grampus, porkpisces," or porpoises, and the shellfish, the names of sixteen were mentioned—"turbut, sturgion, cod, hake, haddock, cole, cusk, or small ling, shark, mackerrell,

[a] An address delivered at Woods Hole, before the Marine Biological Laboratory, on the evening of August 3, 1904; reprinted from Science, revised, and with many additional paragraphs and notes.

The early history may be found given at greater length in the new edition of Goode's American Fishes, edited by Gill and published by Dana Estes & Co., of Boston (1903).

herring, mullet, base, pinacks, cunners, perch, eels." In another paragraph, we are told, "much salmon some haue found vp the Riuers, as they haue passed." Smith claims for the cod that "each hundred is as good as two or three hundred in the New-found Land. So halfe the labor in hooking, splitting, and turning, is saued." He, in short, takes a very practical view of the subject, and has quaintly expressed it. "And is it not pretty sport," says he, "to pvll vp two pence, six pence, and twelue pence, as fast as you can hale & veare a line? He is a very bad fisher, cannot kill in one day with his hooke & line, one, two, or three hundred cods: which dressed & dryed, if they be sould there for ten shillings the hundred, though in England they will giue more than twentie; may not both the seruant, the master, & marchant, be well content with this gaine?"

Doubtless such a report had some influence in determining the trend of immigration into Massachusetts, and one of the newcomers, "a reverend Divine" (Francis Higginson), was ready to confirm Smith's praise, and wrote, in 1630, "The aboundance of Sea-Fish are [sic] almost beyond beleeuing, & sure I should scarce haue beleeued it except I had seene it with mine owne Eyes."

Numerous other chroniclers testified to the richness of the New England seas and gave lists of the fishes. The most lengthy of the lists is that in "An Account of two voyages to New England" by "John Josselyn Gent.," published in 1675; this includes sixty-five names, of which forty-six are those of what we would now call fishes. This list, which is simply a nominal one, supplements slight descriptive notices of eight others which precede it.

It would scarcely repay us, on the present occasion, at least, to give further attention to such lists, but the common names introduced by the early settlers furnish an interesting theme for consideration.

II.

The known fishes of England are few, and the emigrants knew few of them even, and knew those few very imperfectly. When the earliest of those emigrants lived, naturalists even had no idea of the diversity of animal life or the facts of geographical distribution. For instance, John Ray, the best naturalist of his age, who flourished in the last quarter of the same century, thought that there were only "near 500" fishes in the whole world! Naturally, the common people were unprepared to appreciate the diversity of the new life which they were to see.

The immigrants were astonished at the abundance of the fishes about their new home. To these numerous fishes they transferred names of English species with which they were more or less familiar. On account of the greater number of species, or at least of genera, common to the two countries, the emigrants from old England to New

England were not very far astray in many of the names they gave; but as they or their successors wandered farther and farther from their old home, they made many mistakes. A few examples out of the very many will illustrate.

Among the most common of the English fishes are the cod, perch, bass, and trout. The immigrants to Massachusetts applied these names to fishes of the same genera as the originals, or of very closely related genera, but mostly of different species. As population extended into remoter regions and stranger faunas, the meager supply of names had to be doled out to forms quite unlike those to which they had been originally applied.

Cod was at first scarcely at all misapplied, the species being so well known to all, but in a few cases the name was given to the only fresh-water species of the same family—*Lota maculosa*, otherwise called burbot; when the Americans reached the Pacific coast, however, not finding the true cod, they misapplied its name to fishes of very different families, although generally with qualifying prefixes. Thus, the young of the boccaccio (a scorpænoid fish, *Sebastodes paucispinis*), which were caught at the wharves of San Francisco, were dubbed tom-cods; a hexagrammoid fish (*Hexagrammus decagrammus*), also inaptly named spotted rock trout, was by others called rock cod; another species (*Ophiodon elongatus*) was designated as the cod or "codfish where the true cod is unknown," and, where it is known, the cultus cod.

Perch was subject to much greater misuse. In England the name is specifically applied to a well-known fresh-water fish (*Perca fluviatilis*). The immigrants to New England found a fish almost undistinguishable from it, and properly gave it the same name. Others gave it to fishes having no real resemblance; such is the one called also white perch along the Atlantic coast, which is a bass (*Morone americana*); others are sciænids, as the silver perch (*Bairdiella chrysura*), the gray perch (*Pogonias chromis*), and the white perch of the Ohio River (*Aplodinotus grunniens*); another, the red perch (*Sebastes marinus*), is a scorpænid; and still another, the blue perch (*Tautogolabrus burgall*), a wrasse or labrid. The name is also given in some places to various species of a family peculiar to America, the centrarchids, and among them to the black-basses and the sun-fishes. Along the Pacific coast it is given to viviparous fishes or embiotocids; especially, in California, to the alfione (*Rhachochilus toxotes*), and in Oregon and Washington to another, likewise miscalled porgee (*Damalichthys argyrosomus*). The Sacramento River embiotocid (*Hysterocarpus traskii*) is called river perch, or simply perch.

Bass is applied to so many different species—a score or more—that we can not spare the room to enumerate them. In England it is the proper name of a marine fish common only along the southern coast, formerly called *Labrax lupus*, but now named *Dicentrarchus labrax*.

A related species, though of a different genus, was found by the new settlers of Massachusetts and New York, and quite properly called bass or striped bass; it is the *Roccus lineatus* of modern ichthyologists. There are several other species, including the white perch, also entitled to the name. All others are quite remote from the true bass—even the black-basses. These last, however, must retain the name, and it might be better to use always the hyphenated form, i. e., black-bass.

Trout is another of the English names variously misapplied. In the old country it is given to a single species generally distributed through the island in clear cold streams. The Pilgrims found in similar streams in Massachusetts a fish somewhat like it, and called it by the same name, although if good Isaak Walton or some other angler had been among them, he might have told them it was not a trout but a char. Others found in Maine land-locked salmon, and in various large lakes another good-sized salmonid (*Cristivomer namaycush*), and applied to them also the name of trout, but often with a qualifying prefix, as schoodic, or sebago trout, and lake trout. The old specific name was thus applied to representatives of three distinct genera; but the offense was venial, as the genera are closely related and belong to the same family. But this was not the case with others. Settlers in troutless Southern States, bound to give the name to some fish, gave it to the centrarchoid fishes generally known as black-basses. This perversion even found its way into scientific literature, for "Citizen Bosc," French consul at Charleston a little more than a century ago, sent specimens to Paris, with the information that it was called trout, and "Citizen Lacépède" gave it the specific name [*Micropterus*] *salmoides*. Along the southern coast, too, the name trout or sea trout was given to sciænoid fishes of the genus *Cynoscion*. When the Americans reached the Californian coast they found certain fishes of a peculiar family (hexagrammids), not at all like trout in shape or fins, but spotted, and these also they called trout. Still another fish, found in the Gila River, a slender large-mouthed cyprinid, *Gila gracilis*, was called trout by early explorers, and still bears the name.

But this is not all, or the worst! These old names are not only widely scattered; they may be more or less accumulated on one fish. We need only take those already considered as instances.

Cod and trout are given to the same hexagrammids along the Pacific coast. The *Hexagrammus decagrammus*, for instance, is called rock cod about Puget Sound, and rock trout and sea trout at San Francisco. Bass may also be given in some places, as a somewhat related fish, less like a bass (*Sebastodes melanops*), is called black-bass.

Trout, bass, and perch are also given to the black-basses, as already indicated, in various places in the Southern States.

Our forefathers likewise brought with them fish names which have [illegible] in England, but which have entered on a new

life in a new land. One such is alewife (*Pomolobus pseudoharengus*), so familiar in connection with the enormous schools of the clupeid so called, which enter the rivers of New England. So entirely has the name been submerged in England, so prominent has it become in the United States, that it has been supposed by some lexicographers to be of American origin. For example, in that monument of industry and erudition, "A New Dictionary on Historical Principles [etc.], edited by James A. H. Murray, [LL. D., etc.], with the assistance of many scholars and men of science," the etymology of alewife is given in the following terms: "Corrupted from 17th c. *aloofe*, taken by some to be an American Indian name; according to others a literal error for French *alose*, a shad. Further investigation is required." (It is defined "An American fish [*Clupea serrata*] closely allied to the herring.") Further investigation has demonstrated that the supposed etymology is based on errors of several kinds. Too much space would be required to give the details, and those especially interested may find the record (by the present writer) in that receptacle of notes curious and philological entitled, "Notes and Queries" (9th s., VIII, 451–452). In brief, the status is this:

(1) *Alewife* is not only an old English name, but still survives in southwestern England, as attest the works of Couch and Day on English fishes. (2) *Alose*, as such or with literal modifications, has existed as an English word, in certain localities, for centuries, although it was doubtless derived from the French through the Normans. In 1620, the same year that the Pilgrim Fathers left old England and reached New England, one Venner published the statement that "The *allowes* is taken in the same places that sammon is." (3) *Aloofe* is simply the result of a printer's mistaking an old-fashioned median *s* for an *f*. The second John Winthrop sent to the Royal Society an article on "maiz," which was published in 1679 in the Philosophical Transactions (XII, p. 1066).[a] In that article he noted the coincidence of the planting of corn by the Indians and the "coming up of a fish, called *aloofe*, into the rivers." Of course that fish could only have been the one called by his contemporaries, Morton, Wood, and Josselyn, *allize* and *alewife*. (4) *Alewife* is doubtless a mere variant—an accommodative form, perhaps—of the word variously spelled in olden days *alose*, *aloose* (the *oo* has the value of a prolonged *o* sound), *allowes*, *allow*, *alice*, *olafle*, and *oldwife*. (5) The Narragansett Indian name of the alewife was (in the plural) *aumsuog*, according to Roger Williams, or *umpsauges*, according to Stiles.[b] (6) The current English name of one of the shads is *allice* or *allis* shad.

[a] The reference in the English Dictionary is to 1678 (date of presentation of paper), and page 1017.

[b] J. H. Trumbull, in his Natick Dictionary (1903), refers from *aum-sú-og* to *Ommis;* "*ómmis*, pl. + *suog*, herring, C. [=Cotton] 159." The word is believed to be "dim. of aumsuog" and not properly Natick.

Let it not be inferred from this that disrespect is held toward the great new English dictionary. Even the very best are liable to err, and the dictionary is not exempt from the liability, although it does rank among the "very best" and most useful of works; it may be added, too, that an American book to be noticed later on—Smith's Natural History of the Fishes of Massachusetts—may have had some share, indirectly, in misleading the learned Englishmen. Smith says (p. 164): "It has been suggested that alewife is derived from the Indian word *aloof*—signifying a bony fish."[a]

Naturally, the Indians had names for all fishes of economical value, and even for others. A few only, however, were adopted by the new colonists, and those only in forms considerably different from the originals. Such are, besides menhaden, scup, chogset, tautog, and squeteague, still more or less used along the Atlantic coast, namaycush, masamacush, winninish (ouananiche), togue, siscowet, and cisco in the interior, and stit-tse, nissnee, quinnat, kisutch, and eulachon or oolachan along the Pacific coast.

III.

The first special memoir of a really scientific nature on the fishes of this region was communicated in 1794 by William Dandridge Peck, but not published till 1804 in the Memoirs of the American Academy of Arts and Sciences. Peck was then resident at Kittery, N. H., and his memoir was entitled "Description of Four Remarkable Fishes, taken near the Piscataqua in New Hampshire." He aptly prefaces his article with the remark that "that part of the Atlantic which washes the extensive seacoast of Massachusetts affords a considerable number of fishes, many of which are but little known," and, after some further remarks, proceeds to describe the species.

William Dandridge Peck was born in Boston, Mass., May 8, 1763, graduated at Harvard in 1782, and subsequently served for some years "in a counting house in Boston." "He was an ingenious mechanic, and made a microscope and many other delicate instruments." At the same time he was a devoted student of natural history and especially of ichthyology. His studies were crowned in 1805 by the reward of a professorship of natural history in Harvard College, and this was held till his death. He died October 3, 1822.

Let us now return to his memoir. As already noted, the species were four. The first was identified by him with the *Ophidium imberbe*

[a] No reference is made directly by Murray, under *alewife*, to Smith's work, and only, in fact, to Winthrop (1678), Smyth (1867), Craig (1847), Perley (1852), and Lowell (1870). It is probable, however, that Murray had consulted Bartlett's Dictionary of Americanisms (1848, etc.). Bartlett at first derived *alewife* unhesitatingly from "Indian, *aloof*," referring only to "*Alosa vernalis*, Storer, Massachusetts Rep't." In the following explanatory remarks, however, it is less positively asserted that "the name appears to be an Indian one, though it is somewhat changed, as appears by the earliest account we have of it." The only reference by Bartlett to an early author is to Winthrop (1678). Storer did not allude to the etymology or to *aloof*. It is quite likely that Smith's work is the source of information for later writers, though he may have derived the idea from some one else.

of Linnæus; the second received a new name, *Stromateus triacanthus;* the third also has a new name, *Blennius anguillaris*, and the fourth was considered to be specifically identical with the *Cyprinus catostomus* of Forster. Peck's descriptions were very good—for the time at least—and by them his species can readily be recognized.

The first is clearly the species later (1839) named *Cryptacanthodes maculatus* by Storer; Peck's misidentification undoubtedly was very bad, but he manifested a better appreciation of the relationship of the species than did Storer. The *Ophidion* or *Ophidium imberbe* of Linnæus was primarily based on the common gunnell of Europe, *Pholis gunnellus.*[a] Apt as Peck's description was, however, Storer did not recognize his fish. Dekay later (1842) equally failed to recognize it, but, concluding that it could not be the *Ophidium imberbe* of Linnæus, referred it to the genus *Fierasfer* and calls it "*Fierasfer borealis?*" The name was new, and by the interrogation Dekay evidently intended to question whether the species belonged to the genus *Fierasfer* and not whether it belonged to a species already named *Fierasfer borealis.* The correct identification of the species was not published till 1863 (Proc. Acad. Nat. Sci. Phila., p. 332).

Peck's second species is the one now known as *Stromateus triacanthus* or *Poronotus triacanthus;* his third species is *Zoarces anguillaris*, and his *Cyprinus catostomus* is *Catostomus commersonii*, the common sucker of Massachusetts.

IV.

In 1816 the United States was visited by a Frenchman who is well entitled to be considered as the first ichthyological artist of his time—so far superior to all others, indeed, that there was no close second.[b] I mean, of course, Charles Alexandre Lesueur,[c] who was born in Havre on the New Year's day of 1778. He became the companion of François Peron in the notable expedition to southern lands which left Havre in 1800, under the command of Baudin, and was so fruitful of novelties for science. In 1815 he made arrangements with William Maclure by which he was enabled to visit the United States. After a prolonged voyage by way of the West Indies with Maclure, Lesueur

[a] The *Ophidion imberbe* was long a puzzle to European naturalists and the last authoritative author to adopt the name (A. Günther) applied it to a nominal species called *Gymnelis imberbis* and confounded under it names belonging not only to *Pholis gunnellus*, but also others belonging to *Fierasfer* and the common eel (*Anguilla*). Thereupon the present writer published an article "On the affinities of several doubtful British fishes" (Proc. Acad. Nat. Sci. Phila., 1864, p. 199-208), promulgating the views held at present.

[b] I am glad to be able to agree for once with William Swainson, who was much more trustworthy as an artist and art critic than as an ichthyologist. Swainson (Taxidermy, etc., pp. 244, 245) noticed Lesueur as an "inimitable painter, accomplished naturalist, and accurate describer," "the Raffaele of zoological painters," who "left behind him no one, in France, who was qualified to fill his place, or whose delineations for a moment can be compared with his own." He regretted that "no one volume will hereafter point out the matchless excellence of LeSueur."

[c] In the first and second volumes of the Journal of the Academy of Natural Sciences of Philadelphia the name appears as LeSueur, but in the third and forth as Lesueur.

arrived, May 10, 1816, at New York, and there became acquainted with the statesman-ichthyologist Samuel Latham Mitchill. In the fall of the same year he visited the coast, and especially fishing towns, of New England, and the fish market at Boston. His collections afforded him a number of new species, which he subsequently described in various articles in the Journal of the Academy of Natural Sciences of Philadelphia.[a]

In 1817 he settled down in Philadelphia and at once became an intimate associate of the scientific men of that city, and his was the first article contributed to the first volume of the Journal of the Academy of Natural Sciences--that journal which has since extended into so many. It is in that series that were published a number of articles illustrated by his unrivaled pencil. Thirteen specific names were framed for fishes obtained in Massachusetts, but most of them have not stood the test of time and comparison with more material. Lesueur remained at home in Philadelphia, more or less, till 1825. He then accompanied his old patron, Maclure, to New Harmony, Ind., where they hoped to live an ideal life in a socialistic colony. It is almost needless to say that they were disappointed. While in New Harmony, Lesueur issued a prospectus for a work to be published in parts, by subscription[b], on the "Fish of North America, with plates drawn and coloured from nature." The demand for the work was not sufficient to justify its publication, and the project fell still-born. After various adventures and much sickness, he left, by way of New Orleans, for France, and after an absence of twenty-two years was again at Havre in 1837. In Paris and in Havre he passed most of the remainder of his life and for the last two years was director of the museum of the latter city. He died on the 12th of December, 1846.

A very interesting biography of Lesueur by Dr. E. T. Hamy, a

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[a] As already indicated, 13 of Lesueur's species were based entirely or partly on specimens collected in Massachusetts. Reference to the volume and page of the Journal and the present identification of the fish are given in each case:

Muræna bostoniensis (I, 81)	Anguilla chrisypa (Rafinesque 1817).
Muræna argentea (I, 82)	Anguilla chrisypa (Rafinesque 1817).
Gadus compressus (I, 84)	Lota lota (Linnæus 1758).
Catostomus gibbosus (I, 92)	Erimyzon sucetta (Lacépède 1803).
Catostomus bostoniensis (I, 106)	Catostomus commersonii (Lacépède 1803).
Hydrargyra ornata (I, 133)	Fundulus heteroclitus (Linnæus 1758).
Hydrargyra nigrofasciata (I, 134)	Fundulus heteroclitus (Linnæus 1758).
Somniosus brevipinna (I, 222)	Somniosus microcephalus (Bloch & Schneider 1801).
Squalus obscurus (I, 223)	Platypodon obscurus (Lesueur 1817).
Osmerus viridescens (I, 231)	Osmerus mordax (Mitchill 1814).
Clupea fasciata (I, 233)	Pomolobus mediocris (Mitchill 1815).
Clupea elongata (I, 234)	Clupea harengus (Linnæus 1758).
Scomberesox equirostrum (II, 132)	Scomberesox saurus (Walbaum 1792).

[b] Thirty-five plates had been engraved by Lesueur for his projected work, and a sample number with 6 leaves of text (unpaged) and 5 plates (illustrating 3 species of "*Petromyzon*", 1 of "*Ammocœtes*", and 1 of "*Accipenser*") was issued from New Harmony, Ind., in 1827. A notice was published by Leon Vaillant (Note sur l'œuvre ichthyologique de C. A. Lesueur) in the Bulletin de la Société Philomathique de Paris in 1896 (8. ser., t. VIII, 15-33), descriptive of the plates, and a small edition of 40 copies with proofs from the 35 plates was issued by the editor soon after.

member of the Institute of France, appeared in 1904, entitled "Les Voyages du Naturaliste Ch. Alexandre Lesueur dans l'Amerique du Nord (1815–1837)". It was published (1904) in the Journal de la Société des Americanistes de Paris (Vol. V) as a special "Numéro dédié par la Société a l'occasion de l'Exposition Universelle de Saint Louis." It is illustrated by many landscape views reproduced from originals of Lesueur.

V.

Next in order of time comes a work whose like was never seen in any other country, and which has never been equaled. An expert in ichthyology who should see it for the first time without previous knowledge of it, might suppose that the author was an irresponsible idiot who had not intelligence enough to appreciate elementary facts. An ordinarily bad book might be left unnoticed, but the one in question is so abnormally bad as to be a curiosity of ichthyological literature, and interest and wonder must be excited at the variety of errors an educated man may commit in a field of which he has no knowledge. Now hear who this man was and what positions of honor and profit were conferred on him.

Jerome Van Crowninshield[a] Smith was born in Conway, N. H., July 20 (or 22), 1800, was graduated at the medical department of Brown College in 1818, and again at Berkshire Medical School in 1825 (or 1822). He became the first professor of anatomy and physiology in the latter institution. In 1825 he settled in Boston, was port physician from 1826 to 1849, and meanwhile was editor of several medical or other periodicals, among which were the Boston Medical Intelligencer (1823–1826), the Boston Medical and Surgical Journal (1834–1856), and the Medical World (1857–1859). In 1854 he was elected by the Native American, otherwise called the "Know-Nothing" party, mayor of Boston, and served a single term (1854–55). Subsequently he removed to New York, where his son was resident, and was appointed to the professorship of anatomy and physiology in the New York Medical College. During the war of 1861–1865 "he went to New Orleans, where he accepted the position of acting inspector-general, with the rank of colonel, and he was the chairman of a commission appointed by Banks to consider the sanitary condition of the city." He died at Richmond, Mass., at the residence of his sister-in-law, August 21, 1879.

His obituarist, in his old periodical, the Boston Medical and Surgical Journal, records that, "although a man of no great ability, he could turn his hand to almost anything. For instance, it is said of him that as a college boy he was the champion drummer of his class. Later in life he was alternately anatomist, historian, naturalist, poli-

[a] There is a discrepancy between the different biographical sketches of Smith as to name (Crowninshield or Crowningshield) and several dates. Crowninshield is the only form of the name in Boston directories.

tician, a writer of books of travel, sculptor, editor, and orator. He kept a whole set of the Encyclopædia Britannica on his office table and nearly every page was said to have a bookmark in it. He was a successful modeler in clay. Although a busy and active man, his practice was never a large one, but he nevertheless acquired considerable property"—testifying to another important talent!

Smith was a voluminous author and, besides numerous contributions to the periodicals he edited, published nearly a dozen independent volumes on various subjects. The only one of interest in the present connection is his "Natural History of the Fishes of Massachusetts," issued first in 1833, and again, as a "second edition," in 1843.[a] It may be added, however, that he supplied catalogues of the fishes of the state to E. Hitchcock, the state geologist of Massachusetts, which manifested no increase of knowledge of ichthyology.[b] The second edition of the "Natural History" is a mere reissue, apparently, of the unsold remainder of the original with a new title-page and publisher's name. Even the original list of "errata" is retained without any additions. Now let us examine the work and we will find out what a strange production it was.

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[a] The only variations between the two editions are the title pages, viz:

(1) Natural History of the Fishes of Massachusetts, embracing a practical essay on angling. By Jerome V. C. Smith, M. D. [Fig. of Traun Fall.] Boston: Allen and Ticknor. 1833. [12mo, vii + 399 (+1) pp.]

(2) The same. With fifty-four wood engravings. By Jerome V. C. Smith, M. D. [Fig. of Menhaden.] Second Edition. Boston: William D. Ticknor. MDCCCXLIII. [12mo, vii + 399 (+1) pp.]

The character of the work was exposed in "Remarks on the Natural History of the Fishes of Massachusetts. * * * Read before the Boston Society of Natural History, March 20, 1839. By D. Humphreys Storer, M. D." < American Journal of Science and Arts (Silliman's), Vol. XXXVI, July, 1839, pp. 337-349. According to Doctor Storer (p. 348), the work of his compatriot contains "notices of 105 species, of which 80 are foreigners and but 25 are found in the waters of our State. Of these 105 species, 36 are illustrated by figures; of these 36 illustrations, but 9 accompany species which are found on our coast; of these 9 figures, 6 are copied from Strack's Plates and 3 from Mitchill's Fishes of New York; of the 36 illustrations [small wood-cut figures] contained in this history, not one is drawn from nature." The unacknowledged figure of a cataract on the title-page of the first edition appears to be a very poor and much modified reproduction of a cut of "Traun Fall," from Sir Humphrey Davy's Salmonia (4th ed., p. 222), combined with a figure of the "*Salmo hucho*" (p. 231).

[b] The other contributions of Smith to the ichthyology of Massachusetts are mere lists of names, viz:

(1) A Catalogue of the Marine Fishes taken on the Atlantic Coast of Massachusetts. * * * [Also, Fishes found in the Rivers, Mountain Streams, and Ponds of Massachusetts.] < Report on the geology, mineralogy, botany, and zoology of Massachusetts. By Edward Hitchcock. Boston, 1833, pp. 553-554.

A list of 52 nominal species of marine and 17 of fresh-water fishes.

(2) [Revised Catalogue of the Fishes of Massachusetts.] < Op. cit., 1833, pp. 597-598.

A list of 102 nominal species, 83 of which (including the Bodiani = Morone) are salt or brackish water, and 19 fresh-water.

(3) A Catalogue of the Marine and Fresh-Water Fishes of Massachusetts. < Op. cit., second edition. Boston, 1835, pp. 534-538.

A list of the same character as the preceding, enumerating 106 nominal species (and 2 varieties), of which 89 are salt or brackish water and 17 fresh-water. Reproduced (pp. 15-18) in the Catalogues of the Animals and Plants of Massachusetts (edited by Edward Hitchcock), Amherst, 1835, reprinted (same type) from the second edition of the above-cited work.

The catalogue is a repetition of the names (without descriptions or remarks) of the author's Natural History of the Fishes of Massachusetts.

This compilation was also criticised (by Dr. D. H. Storer) in 1837 in "An Examination of the Catalogue of the Marine and Fresh-Water Fishes of Massachusetts, by J. V. C. Smith, M. D.," contained in Professor Hitchcock's Report on the Geology, Mineralogy, etc., of Massachusetts, by D. Humphreys Storer, M. D. < Boston Journal of Natural History, Vol. I, pp. 347-365, Pl. VIII. (May, 1836.)

Smith's chief fountain of information was Mitchill's monograph, "The Fishes of New York described and arranged," published in 1815 in the Transactions of the Literary and Philosophical Society of New York.

He evidently had, as a stand-by, John Stark's "Elements of Natural History," published at Edinburgh in 1828, in which the classification proposed by Cuvier in the first edition of the "Règne Animal" (1817) was followed. This served Smith as a guide for the arrangement of his material. Although the second edition of the "Règne Animal" (1829) had been translated and published in New York a couple of years before (1831), it was unknown to Smith. Another work he referred to as "the Conversations Lexicon;" it was the "Encyclopædia Americana" of those days, which had then been very recently published.

For the illustrations, he had a work long ago forgotten, but which had a considerable circulation in its day. It was Strack's "Naturgeschichte in Bildern mit erläuterndem Text." Of the fish part two editions had been published at Düsseldorf—one in 1819–1826 and the other in 1828–1834. This work was the source of most of the reduced and very poorly engraved woodcuts which accompany the text; three were borrowed from Mitchill's "Fishes of New York." Such are the facts, but in his preface Smith makes no mention of Strack's work and leads up to the supposition that his cuts were original. His words are, "With respect to the engravings, they are far short, in many instances, of what was anticipated. Some of them are beautifully and accurately executed, but others are miserable caricatures. The artist was young and inexperienced, and when he would have willingly made a second drawing the press could not be kept in waiting."

He has certainly told the truth in the acknowledgment that the engravings were "miserable caricatures." They are generally very poor copies of the originals. For example, Strack's figure of the fresh-water lamprey represented correctly seven lateral branchial foramina; Smith's copy only five! A few examples of the many kinds of errors he committed may now be examined; to expose all would require a volume as large as the one noticed.

Under the caption "GEN. SCYLLIAM" three species are claimed for Massachusetts, the sea-dog *Scyllium canicula* (p. 80); the *Scyllium catulus* (p. 81); and the dog-fish *Squalus canis* (p. 82). Now no species of the genus *Scyllium* has ever been obtained from the coast waters of Massachusetts, and the only sharks called sea-dog or dog-fish that could have been known to Smith were the picked dog-fish, *Squalus acanthias*, and the smooth hound, *Mustelus canis*, which last was not named by him.

Gray mullets or mugilids, as everyone here knows, are among the most common of the shore fishes from the Woods Hole region southward, and, under the name *Mugil albula*, were well described by Mitchill in 1814, in New York, but Smith urges (p. 268), "Notwithstanding the minute description there given we think there must be some

mistake, and our private opinion is that no other species than the red mullet is a native fish"! Following up this fancy, under the caption "GEN. SARMULLUS" (a new name!) he specifies (p. 271) the red mullet, *Mullus barbatus*, and, after a break of many pages, immediately after the mackerel (p. 304), he names the surmullet, *Mullus surmuletus*. As to the former, he avers (p. 271) that "red mullet have appeared within the last few years in the neighborhood of Boston, but not being at all prized a few only have been exhibited in the market." The surmullet was declared (p. 304) to be "a variety of the mackerel," and this remark was followed by comments on its place in Roman estimation, on what was evidently the chub mackerel, and on fishing for mackerel!

There is a peculiar genus of gadoidean fishes named *Raniceps*, represented by a single species of northern Europe, and the type of a distinct family, Ranicipitidæ. To this "GEN. RANICEPS" Smith referred two species; one named (p. 209) "Blenny, *Blennius Viviparus* [*Raniceps Trifurcatus*, *Cuv.*]," the other (p. 211) "*Raniceps Blennoides*." The former was evidently the *Zoarces anguillaris* and consequently belongs to a widely different species from the "*viviparus*," a different family from *Blennius*, and a different family also from *Raniceps trifurcatus*. The latter name, we learn from Storer, represented a specimen "purchased of" Smith, by the Boston Society of Natural History, of a *Cryptacanthodes maculatus* "with the cuticle abraded;" consequently the species belongs to a very distinct family from the genus *Raniceps*, as well as from the first species.

Another striking manifestation of ignorance and rashness is displayed in Smith's treatment of two other species. Under the "GEN. COBITIS" (p. 183) he notices the "sucker, *Cyprinus Teres* [*Catastomus*]." In the third paragraph under the specific caption he refers to "a strange fish" given by the keeper of the Boston light-house, unknown "to any of the fishermen in his service, which has a mouth precisely like the fish above described; but the body, instead of being round, is quite thin [!] and wide, back of the gills. The color is silvery, mottled with dark waving lines. It is in length about 10 inches, and appropriately denominated the *sea-sucker*." What could this "sea-sucker" have been? One familiar with the fishes of the coast and with Smith's idiosyncrasy might reconcile the notice with the king-fish (*Menticirrus nebulosus*), but the sucker is a malacopterygian and the king-fish an acanthopterygian, and besides, the latter has a mouth not at all like that of a sucker in reality! All this is quite true, but on an examination of the very specimen mentioned by Smith, it was found by Storer to be a king-fish.

How Smith was led to put the sucker in the genus *Cobitis* and to separate it from its near relation, the chub sucker, *Erimyzon sucetta*, which was placed in the genus *Cyprinus* as the "chub, *Cyprinus oblongus*," is not at all comprehensible.

The habit of assuming that the popular names were correctly applied led to other curious results. Some of the most abundant of the fishes of the state are the cyprinodonts, known as minnows, and the sun-fish called also bream and roach. The cyprinodonts and sun-fish do not appear at all in their proper persons in the "Natural History;" the only mention of any minnow is under the head of "minnow, *Cyprinus atronasus;*" the names of "bream, *Abramis chrysoptera*," "roach, *Leuciscus rutilus*," and "dace, or dare, *Leuciscus vulgaris*," are found, but only in connection with the European fishes, which, it scarcely need be added, are not American fishes.

Still another kind of error is found in statements respecting distribution. As we all know, the shad was introduced into the waters of the Pacific slope by the United States Fish Commission because it was supposed none were there. According to Smith, however, "on the northwest coast of America, they are inconceivably numerous!"

The examples thus given are quite enough to illustrate some of the kinds of errors Smith fell into.

The only item of new or special interest found in the entire volume is not from the pen of Smith, but of a correspondent, Jas. P. Couthuoy, captain of a merchant vessel, who later became known as an able conchologist and accompanied Captain Wilkes in his celebrated voyage around the world. In a postscript to a general letter published in the article on the mackerel, Couthuoy added, "though you are already, perhaps, aware of it, * * * the male dolphin may be easily distinguished from the female in the water by the shape of the head; that of the former being abrupt and almost perpendicular, * * * while the female's is more rounded." This statement, written in January, 1832, and published in 1833, anticipated by five years the discovery of M. Dussumier, announced in the "avertissement" (p. vii) to the twelfth volume of Cuvier and Valenciennes' "Histoire Naturelle des Poissons" (1837). In view of our knowledge of Smith's character, the suggestion that he was aware of such a fact sounds quite ironical. No ichthyologist has recognized the claim of Couthuoy to the discovery in question.

Smith's wretched book misled many of the anglers of the middle of the past century; frequent evidences are to be found of his influence in the principal works (Brown's American Angler's Guide and Herbert's Frank Forrester's Fish and Fishing of the United States) which served as guides to the fishermen of that time; even so able an ichthyologist as Sir John Richardson quoted it and was evidently much puzzled by it.

VI.

The next author whose work demands examination was a man of quite a different character from Smith, and who, for nearly three decades, published the results of studies of the fishes of Massachusetts.

His last work is still the most comprehensive illustrated volume descriptive of the fishes of Massachusetts alone.

David Humphreys Storer was born in Portland, Me., March 26, 1804; attended Bowdoin College and was graduated there in 1822; then studied medicine, and was graduated from the medical department of Harvard College in 1825. Immediately afterwards he established himself in Boston as a general practitioner of medicine. In 1829 he married Abby Jane Brewer, a sister of Dr. Thomas Brewer, later known as a distinguished ornithologist. "In 1837 he cooperated with Jacob Bigelow, Edward Reynolds, and Oliver Wendell Holmes in founding the Tremont Street Medical School. He became interested in natural history, was one of the founders of the Boston Society of Natural History," "had the honor of lecturing to the society two succeeding seasons, 1831-32," on conchology, and in 1838 was elected curator of the herpetological and ichthyological collections. He was also "commissioned" in 1837 as one of the commissioners to report on the zoology and botany of Massachusetts under an act of the legislature "approved 12th April, 1837," and reported in 1839 on the herpetology as well as ichthyology of the state.

In 1854 he was called to the professorship of obstetrics and medical jurisprudence in the medical school of Harvard; in 1859 became also the dean, and held both appointments till 1868. Meanwhile, from 1849 till 1858, he was physician to the Massachusetts General Hospital. In 1866 he served as president of the American Medical Association. He was honored by Bowdoin College in 1876 with the degree of LL.D. In 1883 he retired almost entirely from practice and spent the remaining years of his life in the enjoyment of well-merited leisure. He died in Boston in 1891.

Storer's principal works relative to the region under consideration are "A Report on the Fishes of Massachusetts," published in the Boston Journal of Natural History, in 1839[a]; "A Synopsis of the Fishes of

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[a] The Report was published in the following forms:

(1) A Report on the Fishes of Massachusetts. By D. Humphreys Storer, M. D. <Boston Journal of Natural History, Vol. II, 1839, pp. 289-558, pl. VI-VIII.

Descriptions are given of 107 nominal species, 91 of which are salt or brackish water, and 16 fresh water; in the concluding remarks, 9 additional undeterminate species are indicated as probable inhabitants of the Massachusetts waters.

(2) Supplement to the Ichthyological Report. <Ib., Vol. III, 1841, pp. 267-273.

(3) Additional Descriptions of, and Observations on, the Fishes of Massachusetts. 1842. <Ib., IV., 1844, pp. 175-190.

A second supplement to the report.

(4) Reports on the Ichthyology and Herpetology of Massachusetts. By D. Humphreys Storer, M. D. <Reports on the fishes, reptiles, and birds of Massachusetts. Published agreeably to an order of the legislature, by the commissioners on the zoological and botanical survey of the State. Boston: Dutton & Wentworth, State Printers. 1839. [8vo, xii pp.+2 l.+426 pp., 4 pl.] Pp. 1-253, with half-title—Fishes of Massachusetts—pp. 1-202, pl. 1-3.

The Report on the Fishes is the same as that published in the Boston Journal of Natural History, but (1) an entirely different introduction is added, (2) the supplementary observations on *Carcharias obscurus* (B. J., III, 558) are omitted, and (3) supplementary observations are added (pp. 405-409) on several species.

The plates are evidently printed from the same lithographic stones.

North America," published originally in the Memoirs of the American Academy of Arts and Sciences in 1846[a], and "A History of the Fishes of Massachusetts," also published in the Memoirs of the American Academy of Arts and Sciences, from 1853 to 1867[b]. These were later published as separate works and with independent pagination, and doubtless are in such form constantly referred to at Woods Hole, as they are still the largest complete works that pertain avowedly to the region in question.

The Report of 1839 was a useful compilation of existing knowledge respecting the subject-matter, and for the first time brought together descriptions which could only have been found previously in scattered publications. The classification of Cuvier, then almost universally accepted, was adopted. The material which served for the descriptions in Storer's works was mainly found in a small collection in the Boston Society of Natural History, in the markets, or was supplied by fishermen and by Dr. Leroy M. Yale, a practicing physician of Holmes Hole. Doctor Yale supplied most of the southern forms, and without his aid the Report would have been much more incomplete than it was.

William Yarrell, the author of "A History of British Fishes," not long before published (1836), was an exemplar for the Report, and, as Storer acknowledges, "the generic characters are generally given in the language of Yarrell." In one case, however, *five* is substituted for *free*, and the genus *Gasterosteus* is consequently said to have "one dorsal fin, with five spines before it," whereas Yarrell had printed *free*. Of course the error may be considered typographical. The genera not represented in Britain are defined after the Yarrellian pat-

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[a] The Synopsis was published as follows:

(1) A Synopsis of the Fishes of North America. < Memoirs of the American Academy of Arts and Sciences. New series. Vol. II, (Cambridge, 1846), pp. 253–550.

739 nominal species from all North America (including the West Indies) are described. The descriptions, however, are mostly inaptly compiled and insufficient.

(2) A Synopsis of the Fishes of North America. By David Humphreys Storer, M. D., A. A. S. Cambridge: Metcalf and Company, printers to the university. 1846. [4to, 1 p. l. (=title) +298 pp.]

A reprint, with separate pagination, title-page, and index, of the preceding.

[b] The History was published in parts and as a whole, as hereinbelow indicated:

(1) A History of the Fishes of Massachusetts. By David Humphreys Storer. < Memoirs of the American Academy of Arts and Sciences (Boston), new series, viz:

1. V, pp. 49–92. pl. 1–8, 1853.
2. V, pp. 122–168, pl. 9–16, 1853.
3. V, pp. 257–296, pl. 17–23, 1855.
4. VI, pp. 309–372, pl. 24–29, 1858.
5. VIII, pp. 389–434, pl. 30–35, 1863.
6. IX, pp. 217–263, pl. 36–39, 1867.

134 species are described and (except one—the *Pholis subbifurcatus*=*Eumesogrammus subbifurcatus*) illustrated, and, in an appendix, a nominal list (by Mr. Frederick Putnam, of Salem) of 21 additional species is published. Of the 134 species, 116 are salt or brackish water, and 18 fresh water.

(2) A History of the Fishes of Massachusetts. By David Humphreys Storer, M D., A. A. S. * * * [Reprinted from the Memoirs of the American Academy of Arts and Sciences.] Cambridge and Boston: Welch & Bigelow and Dakin & Metcalf. 1867. [4to, 2 p. l. + 287 pp., 39 pl.; pl. 39 folded.]

As indicated on the title-page, a reprint of the preceding, or rather a collection of extras of the several parts separately and consecutively paged, and with an independent title-page and index. 134 nominal species are described and 133 figured on the 39 plates.

tern. The families were not defined, and in this respect Yarrell was still the exemplar. Yarrell was not followed, however, in the style of synonymy, which was often quite misleading. For example, under the caption *P[eprilus] triacanthus*, Peck (p. 60), are references to (1) "Memoirs of the American Academy of Arts and Sciences, v. ii, p. 48, et fig.;" (2) "Mitchell, Trans. Lit. et [sic!] Philosoph. Soc. N. York, p. 365, et fig.;" and (3) "Cuv. et Valenc. Hist. Nat. des Poiss." In not one of those works does the name "*P. triacanthus*" appear. Peck (in the Memoirs) called the species *Stromateus triacanthus*, Mitchill (not Mitchell[a]) named it *Stromateus cryptosus*, and for Cuvier and Valenciennes (ix, p. 408) it was *Rhombus cryptosus*. Many of the references to pages are also erroneous.

The slight knowledge Storer had of fishes generally entailed on him descriptions deficient in aptness and the element of comparability, and, in a few cases, they were obviously erroneous.[b] "For many years," however, according to his obituarian biographer, "it [the Report] was the standard work on our fishes and was only supplanted in New England esteem by the revised, extended, and fully illustrated work completed in 1867."

The History is really an amplified edition of the Report with some of the species that had been discovered in the meanwhile incorporated, and with plates illustrating all the species described in it but one, the so-called *Blennius subbifurcatus*, which is a typical stichæid. The principal contributor of new material for the History was a master of a fishing vessel, Capt. Nathaniel E. Atwood, of Provincetown, who had acquired considerable knowledge of fishes generally and communicated some interesting notes on habits to the Proceedings of the Boston Society of Natural History.

Storer claims to have "carefully redescribed all the species" for his History, and it has been declared by an eulogist that "it would be difficult to point out a work of greater accuracy in detail." Consequently it has been proclaimed to be "a classic in North American ichthyology that must serve as a basis for the future histories of the New England fishes." Naturally such a work calls for examination. If some discrepancy shall be found to exist between the estimate of

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[a] Mitchill's name was always spelled Mitchell by Storer in his Report; he corrected it in later papers and in his History.

[b] One new genus and 10 nominal new species were described in the Report, 4 of which are recognized at the present time. The 4 of acknowledged validity are indicated in the following list by italics:

Cryptacanthodes (n. g.) *maculatus*, Storer (p. 28).
Pholis subbifurcatus (p. 63) = *Eumesogrammus subbifurcatus* (Storer).
Leuciscus argenteus (p. 90) = Semotilus corporalis (Mitchill, 1817).
Leuciscus pulchellus (p. 91) = Semotilus corporalis.
Morrhua americana (p. 120) = Gadus callarias Linnæus, 1758.
Platessa ferruginea (p. 121) = *Limanda ferruginea*, Storer.
Echeneis quatuordecimlaminatus (p. 155) = Remora brachyptera (Lowe, 1839).
Syngnathus fuscus (p. 162) = *Siphostoma fuscum*, Storer.
Syngnathus peckianus (p. 163) = Siphostoma fuscum, Storer.

the eulogist and that now to be presented, it must be remembered that the former was hampered by the demands of a memorial celebration, while on the present occasion only the facts need be considered.

In the sixth decade of the past century the classification proposed for the fishes by Cuvier, in 1829, in the second edition of the "Régne Animal," was still regnant. Naturally, then, Storer adopted it for his History, as he had previously for his Report. He added diagnoses of the families which were in almost all cases translations of the essential characteristics assigned to them by Cuvier. In the author's nomenclature he was "guided, as far as possible, by the principle which would give the credit of a species to the author who first placed it under its appropriate genus. This plan," he truly added, he "was led to understand is being adopted by our most eminent naturalists." For a time such was the case.

The work was and is of such importance that some analysis may be welcome.

As long as the writer had a guide to follow his faults of taxonomy were mainly those of his guides, but he had the fortune, good or bad, to obtain specimens of types unknown to the authors whose views he followed, and then he had to determine their affinities as best he might. The result by no means did credit to his perspicacity. Among these types were the genera *Boleosoma* and *Cryptacanthodes*. *Boleosoma* had been quite correctly referred by Dekay to the family of Percidæ, and is in fact a perch in miniature. Yet Storer referred it to the "Triglidæ," between *Acanthocottus* and *Aspidophorus* (*Aspidophoroides*), in spite of the fact that he declared (after Cuvier) that "their general character consists in having the suborbital bone more or less extended over the cheek and articulated behind with the preoperculum." Why he should have referred to such a family a genus with the suborbitals reduced to such an extent that they had been said to be absent is a mystery which he made no attempt to explain.

Cryptacanthodes was first named by Storer in 1839. It is an elongated naked fish without any enlarged suborbital bones and entirely unlike any recognized triglid. On the other hand, it has many characters in common with genera of the family of "Gobidæ" (as he called it), and in accordance with his own definition he should have referred it to that family. In fact the genus is the type of a peculiar family nearly related to that of the gunnells.

The same ineptitude for the appreciation of characters or form is manifest in the treatment of species which he actually referred to the family "Gobidæ." To the genus *Blennius* was relegated a species named *Blennius serpentinus*, and to the very closely related genus *Pholis* was assigned another species named *Pholis subbifurcatus*. Now the true species of *Blennius* and *Pholis* have a very characteristic physiognomy, and only differ from each other in the fact that the former

has skinny tufts over the eyes, which are wanting in the latter. Yet the *Blennius serpentinus* has a very elongated form and no superciliary tufts, and the *Pholis subbifurcatus* has also an elongated form, and therefore no resemblance to a true *Pholis*. In fact the two species belong to a different family from *Blennius* and *Pholis*, and are related to each other. They are the stichæids now named *Leptoblennius serpentinus* and *Eumesogrammus subbifurcatus*.

The want of appreciation of the value of words as well as of natural relations was also manifested in the treatment of the flat-fishes. Cuvier had divided the typical pleuronectids into three genera, or, as he called them, subgenera: *Platessa*, distinguished by a row of obtuse trenchant teeth on the jaws; *Hippoglossus*, having strong pointed teeth, and *Rhombus*, including the turbots. While professedly adopting these genera, he referred to *Platessa* several species (*dentata*, *oblonga*, *quadrocellata*), which are really more nearly allied to the halibut and European species associated with that fish. Cuvier had not referred to the American species, and Storer had consequently to do for himself.

The last genus that requires attention is *Carcharias*. The part of the History referring to it was published in 1867. As early as 1841 Müller and Henle had published their great work on plagiostomes and the sharks of the American coasts had long been referred to their proper genera; but all the labor was lost, so far as Storer was concerned. Four species were referred by him to the genus. Only one (*obscurus*) has the characters assigned in the diagnosis. One (*griseus*) is an *Odontaspis*, another (*vulpes*) an *Alopias*, and the fourth (*atwoodi*) is the great white shark (*Carcharodon carcharias*). It will be thus seen that his four species of *Carcharias* belong to four families of Müller and Henle and most modern systematists.

If we examine his descriptions we too often find that while they fill every requisite as to length, there is too much perfunctory verbiage and too little precision. For example, the "form" of the striped bass, as well as of "the Spanish mackerel" (*Scomber dekayi* or *colias*), is said to be "cylindrical," while the common mackerel is claimed to have the "body elongated." Now there is really no difference in form between the two mackerels[a], and that form is as nearly fusiform as any fish can have. Anyone who knows what a cylinder is would be so misled by Storer's description that he would be precluded from identifying the striped bass from the description—if he relied on it. The mackerels are certainly elongated, but so is an eel and so also is a hairtail. It is evident, therefore, that the unqualified adjective is altogether too vague and meaningless. These examples of the want of precision and misuse of terms must suffice.

Another feature which may excite the surprise of the new student

[a] In his Report (p. 46) Storer attributed to "*Scomber colias*" a "*form elongated*, very round and plump," and omitted all mention of the form of "*Scomber vernalis*." The italics are Storer's.

is the meagerness of the information respecting habits of species. There are some statistical data concerning the mackerel, herring, and cod, some observations on the habits of the sun-fish, toad-fish, and trout, and briefer references to others, but the parental care exercised by the sticklebacks and cat-fishes, and the peculiarities of others, are not even alluded to. Comparatively little was known in those days of such matters, it is true, but information about the characteristics mentioned was already existent in the literature.

The best part of the work is the collection of plates. These are really for the most part excellent and among the best that have ever been published. Most of them were prepared by A. Sonrel, who had been trained for such work by Louis Agassiz. But the want of supervision was occasionally evident even here. For example, adopting the fashion then prevalent, scales from the back and lateral line were illustrated for almost every scaly fish. Now the most characteristic feature of the scales of the sparoid fishes is the divergence of the striæ across the field above and below and their intersection of the margins. Sonrel had represented the fine concentric striæ of the scales of the early families correctly, but, in place of well-marked striæ for the sparoids, he gave meaningless dots (pl. 10, f. 2, 3, 5, 6); apparently he had perceived something anomalous to him in the sparoid scales, but was afraid to represent what he saw and adopted the device of obscurity and ambiguity expressed in punctulation.

Another case of bad iconography was exhibited in the figure of the so-called *Blennius serpentinus* (pl. 17, f. 1.) Storer conceived for this fish a very deeply divided dorsal whose parts were "connected by a membrane" (p. 91). Probably the fin had been injured; in a perfect specimen the fin is uninterrupted. The artist may have been influenced by the ichthyologist; possibly the ichthyologist may have been misled by the artist; anyway, the representation of the fin accords with the description and not with nature.

It will be evident that all the criticisms that have been passed on the History are those that might have been made at the time the parts were published. In the allocation of some of the genera and species the author sinned against his own definitions. His nomenclature has not been considered as such and need not be. Respecting that, hear what his obituary biographer had to say: "In the time that has passed since its publication we have changed our ideals of names, and discoveries of new genera or species, or in the anatomy, have compelled changes in our system. The nomenclature of the book has become somewhat antiquated, and the systematic arrangement is not entirely suited to the present time." His eulogist has further truly remarked that Doctor Storer "used little of his energy in searching for generalizations." In fact, the only evidences he has left of any attempts at generalization were a simple table of the geographical dis-

tribution of genera of North American fishes and the isolation of the genus *Amblyopsis* in a family he called "Hypsæidæ."[a] We may pass them without comment save that they were laudable attempts at least.

I have alluded to these defects of Storer's work because for a long time they influenced our conceptions respecting the fishes of the coast and were generally adopted. The errors were repeated by Dekay in 1842 and (pardon the expression of personal experience) the discrepancy between the facts and the print sadly perplexed my boyish studies and for a time made me fear that failure to understand was the fault of my stupidity rather than Storer's and Dekay's errors. In fact, they remained uncorrected till I had to demonstrate that the statements were inconsistent with the facts and formulated the views now prevalent.[b]

VII.

In 1872 was published an article which would not call for notice, since it is devoted to a limited locality and covers a very short period, were it not that the locality is very near Woods Hole and that it ema-

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[a] Mem. Am. Acad. Arts and Sci., n. s., II; Syn. Fishes N. A., pp. 4-8; 183, 184, 1846.

[b] Five new specific names appeared for the first time (with descriptions) in the History, viz:

Scomber Dekayi (Mem. Amer. Acad. v, 130; Hist. 52)=Scomber scombrus (Linnæus, 1758).

Thynnus secundo-dorsalis (Mem. Amer. Acad. v, 143; Hist. 65)=Thunnus thynnus (Linnæus, 1758).

Blennius serpentinus (Mem. Amer. Acad. v, 257; Hist. 91)=Leptoblennius lampetræformis (Walbaum, 1792).

Anarrhicas vomerinus, Agassiz, Ms. (Mem. Amer. Acad., v, 265; Hist. 99)=Anarrhichas lupus (Linnæus, 1758).

Phycis filamentosus (Mem. Amer. Acad., vi, 417; Hist. 189)=Urophycis chuss (Walbaum, 1780).

Before and between the periods covered by the publication of the Report and History, Storer published, in the Boston Journal of Natural History and Proceedings of the Boston Society of Natural History, descriptions of a number of nominal new species, viz:

Ostracion Yalei (Boston Journal 1, 1836, 353)=Lactophrys trigonus (Linnæus, 1758).

Hydrargira trifasciata (Boston Journal 1, 1837, 417)=Fundulus majalis (Walbaum, 1792).

Gasterosteus mainensis (Boston Journal 1, 1837, 405)=Pygosteus pungitius (Linnæus, 1758).

Myliobatis bispinosus (Proc. Bost. Soc. 1, 1841, 53)=Myliobatis freminvillei (Lesueur, 1824).

Lota Brosmiana (Boston Journal 4, 1842, 58)=Lota lota (Linnæus, 1758).—Described from "a beautiful fresh specimen" "received from Lake Winnipissiogee," but the species also occurs in Massachusetts.

Etheostoma Olmstedi (Boston Journal 4, 1842, 61)=Boleosoma nigra olmstedi.—Described from specimens "found at Hartford," Conn., but the species is also a Massachusetts fish.

Pomotis rubri-cauda (Boston Journal 4, 1842, 177)=Lepomis auritus (Linnæus, 1758).

Torpedo occidentalis (Amer. Jour. Sci. and Art, 45, June, 1843, 166)=Tetronarce occidentalis (Storer, 1843).

Hydrargira formosa (Proc. Bost. Soc. 1, 1842, 76)=Fundulus majalis (Walbaum, 1792).

Platessa glabra (Proc. Bost. Soc. 1, 1843, 130; not Rathke, 1837)=Liopsetta putnami (Gill 1864).

Leptocephalus gracilis (Proc. Bost. Soc. 2, 1845, 76)=Leptocephalus conger (Linnæus, 1758).

Prionotus pileatus (Proc. Bost. Soc. 2, 1845, 77)=Prionotus carolinus (Linnæus, 1758).

Alosa cyanonoton (Proc. Bost. Soc. 2, 1847, 242)=Pomolobus æstivalis (Mitchill, 1815).

Alosa lineata (Proc. Bost. Soc. 2, 1847, 242)=Pomolobus mediocris (Mitchill, 1815).

Platessa quadrocellata (Proc. Bost. Soc. 2, 1847, 242)=Paralichthys oblongus (Mitchill, 1815).

Motella caudacuta (Proc. Bost. Soc. 3, 1848, 5)=Rhinonemus cimbrius (Linnæus, 1766).

Blennius serpentinus (Proc. Bost. Soc. 3, 1848, 30; named only)=Leptoblennius lampetræformis (Walbaum, 1792).

Carcharias Atwoodi (Proc. Bost. Soc. 3, 1848, 72)=Carcharodon carcharias (Linnæus, 1758).

Zeus ocellatus (Proc. Bost. Soc. 6, 1858, 386)=Zenopsis ocellatus (Storer, 1858).

In the Memoirs of the American Academy of Arts and Sciences (2. ser., vol. 2), and in the "Synopsis of the Fishes of North America," reproduced from it, in 1846, two new names were introduced for Massachusetts fishes, viz:

Monacanthus signifer (Mem. 497, Syn. 245; M. setifer DeKay, not of Bennett)=Monacanthus hispidus (Linnæus, 1766).

nated from such distinguished ichthyologists as Dr. Franz Steindachner and Professor Agassiz, under the editorship of Col. Theodore Lyman. The article is a catalogue of the "Fishes taken in the Waquoit weir, April 18 to June 18, 1871," and was published in the Sixth Annual Report of the Commissioners of Inland Fisheries (pp. 41–58, pl. 1–2). We are told that "most of the nomenclature is by Dr. Franz Steindachner; and some notes by Professor Agassiz are added, marked A." Only 44 species were obtained. The nomenclature for the most part is that prevalent during the previous half century, and not that which had been in general use for the preceding decade and is prevalent now. Some interesting statistical and biological data are given. No species previously unknown to the state or region in question were added.

This was the last authoritative faunal contribution of Massachusetts naturalists. The labors of the excellent ichthyologists of the state, chief of whom, for many years, has been S. E. Garman, have been with excellent judgment devoted to the elucidation of questions of embryology, morphology, and taxonomy. The greater facilities enjoyed by the United States Bureau of Fisheries have been recognized and the task of formal registration has been left to those directly or indirectly connected with that organization.

VIII.

Before Storer's History was completed and before the Waquoit weir was examined Prof. Spencer F. Baird visited Woods Hole and spent part of several summers there with his family. His first visit was made in 1863. He then found 47 species, and among them, for the first time, the very young of *Trachynotus carolinus* and *T. ovatus* (*falcatus*). These as well as *Cyprinodon variegatus* were recorded by Gill in the Proceedings of the Academy of Natural Sciences for 1863 (p. 322), and later, with other material, served as the basis for the reduction of three genera of earlier American ichthyologists to one species, and of the generalization respecting the mode of development and growth of the carangids and scombroideans generally.

The United States Fish Commission was established in 1871, and the village that the commissioner had proved as a private was selected by the officer as a station of the new commission. With government means for exploration, many species previously unknown to the coast were added, and up to 1873 not less than 23 species, new to the region, were found, exclusive of those already referred to. These were enumerated in a "List of the Fishes Collected at Wood's Hole, by S. F. Baird," published in the Report of the United States Commission of Fish and Fisheries for 1871–72 (pp. 823–827). The list was one of names (scientific and popular) only, arranged in accordance with Gill's "Catalogue of the Fishes of the Eastern Coast of North America" printed just in advance of it.

IX.

Conspicuous publishers of an enumeration of Massachusetts fishes were G. Brown Goode and Tarleton H. Bean, connected with the United States Fish Commission. Under the form of "A Catalogue of the Fishes of Essex County, Massachusetts, including the Fauna of Massachusetts Bay and the Contiguous Waters", they gave the names of all the species known from the state. "It is believed to be complete to the date of publication." The catalogue was published in 1879 in the Bulletin of the Essex Institute (XI, pp. 1–38). The sum total listed amounted to "183 species, of which 163 inhabit salt or brackish water, 20 fresh water." The "number of marine species from within the limits of Massachusetts Bay * * * is 133; while 29 are from the deeper offshore waters in the vicinity of Georges, Le Have, Browns, and Sable Island Banks." Only 20 of the species have exactly the same names that were adopted by Storer.

As just indicated, a number of the species enumerated by Goode and Bean have never been found except in deep offshore waters, and consequently not within the limits of the state or even very near it. There are 24 such, and they should be excluded from the fauna of the state. These are deep-sea or pelagic forms, which are more foreign to the real fauna of Massachusetts than are the fishes of Florida or of Britain.

The catalogue of Goode and Bean, on the whole, is a well-considered and valuable memoir, brought up to the date of its publication.

X.

The last census of the fishes of Massachusetts relates to a part of the coast, but that the most important from an ichthyological point of view at least; it is a catalogue of "The Fishes Found in the Vicinity of Woods Hole," by Dr. Hugh M. Smith, chief of the division of scientific inquiry, United States Fish Commission, now Deputy Commissioner of the Bureau of Fisheries. It was published in advance and appears in the Bulletin of the United States Fish Commission for 1897 (XVII, pp. 85–111, with folded map). It was supplemented in two later volumes (XIX, 309, 310; XXI, 32). These give a most useful summary of the fishes of the region indicated, enriched with notes respecting occurrence, comparative rarity or abundance, and time of appearance. The species are arranged in the sequence adopted by Jordan and Evermann, and their nomenclature also is accepted. The number of species recorded in the main list was 209; in 1899, 16; and in 1900, 4. The present number of fishes recorded up to date is 229 marine species, and if to these we add 11 fresh-water ones occurring in the vicinity, we have no less than 240. It is remarkable that at so late a day so many species previously unknown to the coast should have been found.

Doctor Smith, in his main article, enumerated 23[a] such species; in 1899 added 16[b], and in 1900, 4 more[c]. No additional ones have been discovered since[d]—a fact by no means surprising. The additional species, with one exception, were known estrays from tropical waters; the exception was supposed to have been previously unknown and was described as *Chætodon bricei*.

If we now first subtract from Goode and Bean's catalogue of the fishes of Essex County 24 species which are deep-sea forms not yet found in Massachusetts Bay, we shall have left 36 species which have not been found about Woods Hole. These, added to the 240 actually found there, and 5 more from fresh water will give us a total of 281, the number of species now known to have been found at some time or other along the coast of Massachusetts or in her interior waters.

XI.

A specially notable feature in the late enumerations and additions to the fauna of southern Massachusetts is the great number of young tropical fishes and the comparative or total absence of adults. Sixteen species were added in 1899 to the piscine visitors to Woods Hole and 4 in 1900, and of these no less than 18 were the young of typical tropical forms. In round numbers, about 3 dozen species of tropical fishes have been found along the coast, represented only or almost only by the young—often the very young. In olden times when persons believed, or thought they believed, that all fishes laid eggs at the bottom, it would naturally have been inferred that such young must have been hatched close by, and that the parent fishes had spawned in the northern seas. Such an inference, with our present knowledge, is quite unjustifiable. We now know that a very large proportion of fishes develop pelagic or floating eggs and not demersal ones. If such fishes, then, would discharge their ripened ovarian burdens near the surface of the open sea where currents would carry them northward,

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[a] No less than 24 species were added to the piscifauna of southern Massachusetts, the majority of which were represented by young wanderers from the south, indicated by italics.

Tarpon atlanticus, Opisthonema oglinum, *Trachinocephalus myops*, Lucania parva, Athlennes hians, Gasterosteus gladiunculus, *Polydactylus octonemus*, Oligoplites saurus, *Caranx bartholomæi*, *Trachinotus goodei*, *Neomænis griseus*, *Neomænis jocu*, *Neomænis apodus*, Neomænis aya, *Neomænis analis*, Larimus fasciatus, Sciænops ocellatus, Pogonias cromis, *Chætodon ocellatus*, *Chætodon bricei* [=*Chætodon capistratus*, young?], *Chætodon striatus*, *Canthidermis asperrimus*, *Spheroides spengleri*, Sebastes marinus.

[b] The following species were added in 1899, all represented by young individuals except the Muræna, Apogon, and Lactophrys tricornis:

Muraena retifera (a specimen "6 feet 2 inches in length," was taken in a lobster pot; the species was previously known only from the type taken in deep water off the South Carolina coast); Holocentrus, Apogon maculatus, Epinephelus morio, Epinephelus adscensionis, Garrupa nigrita, Mycteroperca bonaci, Mycteroperca interstitialis, Eupomacentrus leucostictus, Scorpæna plumieri, Scorpæna grandicornis, Teuthis coeruleus, Teuthis hepatus, Teuthis bahianus, Lactophrys triqueter, Lactophrys tricornis (an adult 15½ inches long washed ashore).

[c] The specimens obtained were young, but probably not of the first year. The size in inches and date of capture are specified in each case: Exocœtus rondeletii, October 13, 7.25 inches; Ocyurus chrysurus, October 4, 5.5 inches; Scarus croicensis, October 20, 3 inches; Sparisoma flavescens, November 13, 6 inches.

[d] An adult specimen of Brama raii was obtained in a trap net of the Bureau of Fisheries at Nomans Land in September, 1904.

many of the young in time would be drifted into high latitudes. Not a few of these involuntary travelers, by fall time, might reach the latitude of Woods Hole or near it, and winds blowing shoreward might account for their presence along the coast. We know that the parent fishes live close to the Gulf Stream in southern Florida and masses of gulf weed are frequently drifted on the nearby coast. This was especially the case in the year when young tropical fishes were found in such numbers along the coast. It would be interesting to follow the long voyages of such travelers.

Here, then, is a field which the Bureau of Fisheries and the laboratories at the Tortugas and Beaufort might investigate. The towing-net is as necessary a tool for the biologist as the dredge, and surface-collecting, though it may not yield as many new species, will add more to our knowledge of the life-histories of many common animals than dredging. While grateful for all these agencies, and especially to the United States Fish Commission (now the Bureau of Fisheries), for what has been done, let the past be the presage of a still more active and fruitful future. May American enterprise rival the patriotic efforts of Danish sailing masters and gather materials which shall compare with those which Christian Lütken used so well, long ago, in the elucidation of pelagic fishes. As to the special piscifauna of Massachusetts, a future task will be to subtract rather than to add. A problem to determine must be what shall be considered as fishes really belonging to the fauna. Certainly inhabitants of the deep seas, which never approach the territorial limits of a state, can not properly be considered as members of the fauna. Such types as the chimærids, simenchelyids, synaphobranchids, nemichthyids, saccopharyngids, alepocephalids, alepisaurids, chauliodontids, and macrurids are characteristic constituents of the deep-sea or bassalian realm. The involuntary estrays from tropical seas, whose lives are terminated with the increasing cold of the fall and winter months, also can not claim to be reckoned as constituents of the fauna. They are representative of a very distinct realm—the Tropicalian. They do, however, furnish very useful hints for the determination of zoogeographical problems. We have the evidence that in times past a few estrays from tropical families have established homes far from those of their kindred. All such problems and considerations, however, must now be left for the future and for other hands.

THE DISTRIBUTION OF SEWAGE IN THE WATERS OF NARRAGANSETT BAY, WITH ESPECIAL REFERENCE TO THE CONTAMINATION OF THE OYSTER BEDS

By CALEB ALLEN FULLER
Assistant in Wisconsin State Hygienic Laboratory

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THE DISTRIBUTION OF SEWAGE IN THE WATERS OF NARRAGANSETT BAY, WITH ESPECIAL REFERENCE TO THE CONTAMINATION OF THE OYSTER BEDS.[a]

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INTRODUCTION AND REVIEW OF LITERATURE ON "OYSTER INFECTION."

More than twenty years ago attention was called to the fact that oysters and other shellfish which are eaten raw might be the cause of some of the outbreaks of typhoid fever and cholera which have occurred from time to time in certain coast towns of England and Ireland. Among the first to support this view strongly was Sir Charles Cameron. After examining some oyster beds on the northern shore of Dublin Bay, he suggested that "oysters taken from this source were quite as likely to be a source of typhoid infection as milk or water." He found these oyster beds in a most unhealthy condition. The oysters were sick and died in large numbers every year. Investigation of the beds showed them to be "literally bathed in sewage," and the oysters were found to contain sewage matters within the shells. In 1880 he read before the British Medical Association a paper entitled "Oysters and typhoid," in which he called attention to the fact that contaminated oysters might be the cause of these outbreaks of typhoid fever and cholera in the coast towns of England and Ireland.

No special interest was manifested in this statement until, in 1893, Doctor Thorne-Thorne, in his report to the local government board for that year, gave it as his opinion that certain sporadic cases of cholera which had occurred at various inland places in England in that year were due to oysters and other shellfish from sewage-contaminated water at Grimsby, where there had been a small outbreak of the disease. Following out Doctor Thorne-Thorne's suggestion, the Government commenced an exhaustive series of investigations, the results of which have appeared in the annual reports of the local government board. This work was carried out under the direction of Doctors Bulstrode and Klein.

[a] Thesis submitted to the faculty of Brown University for the degree of Doctor of Philosophy.

In brief, the results of their experiments are the following: "The oyster does not, under normal conditions, contain, either within its body or in the liquor inclosed by its shell, any microbe than can grow in phenolated gelatin or in phenol broth." Three species of bacteria were isolated from normal oysters. "A minute motile bacillus, capable of liquefying gelatin very rapidly," is "by far the most abundant micro-organism in the ordinary oyster." "Occcasionally only, a spore-forming, motile bacillus is also obtained, which corresponds culturally to *B. vulgatus.* A nonliquefying bacillus is, too, as a rule, present, which differs culturally from *B. coli* in the circumstance that it will not grow in broth at 37° C. The number of microbes of the above sorts present in the liquor and in the body of the oyster varies greatly in different samples; of oysters from the same batch, some afford few, some innumerable colonies to the gelatin-plate culture test. Having satisfied myself in the above sense that bacteria of excremental origin are not, in the ordinary course, apt to be contained within oysters, I set myself to ascertain whether *B. coli* and *B. typhosus* were not discoverable in oysters * * * from sources under more or less suspicion of sewage contamination."

The media used for these tests were phenol broth and gelatin. The results of the examination show that "Oysters from a few out of numerous batches derived from sources where they did appear to be exposed to risk of sewage contamination were found to exhibit colon bacilli. In one case where the circumstances were especially suspicious, Eberth's typhoid bacillus was found in the mingled body and liquor of the oyster." Though Doctor Klein regards the presence of colon organisms in oysters as an indication of sewage contamination, he was not able to show a constant relation between sewage contamination of the water and the presence of these organisms in shellfish. Certain batches of oysters from apparently polluted waters were found to contain *B. coli*, while other lots from apparently equally polluted sources did not give positive reactions for this bacillus.

In 1894 was published the report of Doctor Conn's careful investigation of the famous outbreak of typhoid fever, which occurred at Wesleyan University in October of that year. The account of this epidemic is familiar to all, and only the main facts of the case will be referred to at this time. On October 12 seven college fraternities had their initiation ceremonies and celebrated in the usual way with a supper. Eight days after several students were reported sick, with a moderate degree of fever, and shortly after November 1 twenty-three cases of typhoid fever had developed. Investigation proved beyond a shadow of doubt that the water supply was above suspicion and that the sanitary condition of the boarding and lodging houses was perfect. All the men affected were members of three fraternities which had obtained their oysters from a local dealer. One other fraternity had

oysters from the same dealer, but these were eaten cooked, while the other three lots were consumed raw. Two of the remaining three fraternities did not have oysters, and the other one obtained its supply from a dealer in Hartford. Only one non-fraternity man contracted the disease, and the investigation of his case only established more firmly the responsibility of the local supply, for this man had eaten of the same lot of oysters at the dealer's shop. Inquiry brought out the fact that two of five men from Yale who attended the exercises of the societies were seized with typhoid fever some time after their return to New Haven. Further investigation showed that the infected oysters had been stored at the mouth of the Quinnipiac River, 300 feet from the outlet of a small drain from a house in which two persons lay sick with typhoid fever.

In 1894, Doctor Casey reported in the British Medical Journal a case of fatal "oyster poisoning," and since that date the pages of this publication contain frequent references to the subject of "oyster infection."

In 1895, Sir William Broadbent published the facts of a series of cases and groups of cases of typhoid fever and other gastro-intestinal illnesses, which he concludes were caused by the ingestion of raw oysters. There was no bacteriological evidence that the oysters were polluted, but circumstances pointed strongly to these shellfish as the cause of the disease. The following case is typical of those reported. Sir William was called to see a young woman who, ten to fourteen days previous, had eaten some raw oysters in company with a cousin. She developed a mild case of typhoid, as did also the cousin, who had gone to Italy. Another similar case: A clergyman and his daughter, living in the country where typhoid was unknown, were seized with this disease. Inquiry revealed the fact that they had eaten raw oysters in London while on a visit to that city some two weeks previous.

In the same year Sir Peter Eade emphasized the fact that mussels and other shellfish, as well as oysters, might become a source of infection. Doctor Wilson reported three instances, occurring in Florence, where persons who had eaten raw oysters were taken sick with typhoid fever, while other persons in the same parties who did not eat oysters were not ill. A little later Doctor Johnson-Lavis reported some cases of typhoid and gastro-intestinal disorders of a very severe type which he encountered in his practice in Naples in 1879. These illnesses were most prevalent among strangers who had eaten raw oysters. Investigation showed that oysters were brought to Naples from seacoast towns, where there was no typhoid, and stored for a long time in the harbor in a bed less than 60 feet distant from the outlet of one of the main sewers. These oysters were filled with sewage matters, and "when they were consumed about a tablespoonful of sewage water was swal-

lowed." He is positive that these oysters are responsible for the prevalence of these diseases in Naples at that time.

In 1896 Doctor Chantemesse reports a number of cases of typhoid in a village where there had been no cases of that nature for over a year. Fourteen persons in the village ate a lot of oysters from Cette and were made sick. Others of the same families who had not eaten of this lot suffered no inconvenience. Eight of the fourteen were slightly ill and four others very severely ill, with diarrhea and intestinal disturbances. The two remaining persons developed very severe cases of typhoid fever, one of which terminated fatally. Bacteriological examination of oysters from several localities demonstrated the presence of *B. coli* in large numbers.

Doctor Mosny, who has made a most careful and thorough investigation of the whole subject of mollusk poisoning in France, reports a case of "oyster infection" in a village near Paris in 1900. Five members of a family of seven were stricken with severe gastro-intestinal disturbances after eating some oysters from Cette.

Many other similar cases are reported in the French medical literature, the conclusions, however, all based on circumstantial evidence.

In 1900 Doctor Plowright reported a number of cases of enteric fever, due to contaminated clams. In the village of North Lynn (entire population 70) 30 persons ate clams on several occasions in May and June. Of the 30 who ate the clams, 15 consumed them raw and 10 of the 15 came down with typhoid fever. None of those who ate them cooked experienced any trouble. The "clams were dug in a mud flat at the mouth of the Great Ouse, 3 miles below the point at which the town of King's Lynn discharges its untreated sewage. * * * Similar cases of enteric fever following the consumption of uncooked clams have simultaneously been observed in the town itself and in other surrounding villages."

In 1900 the Philadelphia Medical Journal published the account of several cases of typhoid occurring at Portland, Me. Four of an Italian crew came down with typhoid some time after eating mussels which they had gathered from the piles beneath a wharf near which is the outlet of one of the city sewers.

In 1902 Dr. J. C. Thresh published in the Lancet of December 6 the account of 21 cases of typhoid and gastro-intestinal disturbances, which he ascribes to the consumption of raw oysters. His account includes the histories of six families in which the illnesses occurred only among persons who had eaten oysters. The cases ranged in severity from one fatal case of typhoid to slight intestinal disturbances. One instance of special interest is the following: All members of a certain family ate these contaminated oysters, and, with the exception of one person, all were sick. This person, not liking the taste of the oysters, did not swallow any and was not made ill.

Bacteriological examination of oysters from the common source revealed the presence of *B. coli* and *B. enteritidis* Gärtner, but not *B. typhosus*.

In the same year it was reported at a meeting of physicians at Pera, Turkey, that a large percentage of typhoid cases which occurred in Constantinople could be traced to the consumption of oysters from polluted sources. Examination demonstrated the presence of *B. coli* in many and of *B. typhosus* in a few specimens.

Also, in 1902, an extremely large number of typhoid cases was reported in Atlantic City, N. J., during the summer months. A very careful investigation of the sanitary condition of the water supply, the milk and food supply, and of the sewage-disposal system was made by Philip Marvel. He came to the conclusion that the increase in the number of these cases was due, in a great measure, to oysters fattened near the outlet of one of the city sewers.

In November, 1902, occurred also the famous "oyster epidemics" at Winchester and Southampton, England, which were investigated by Doctor Bulstrode and reported to the local government board in May, 1903. At two banquets given by the mayors of these cities 267 guests were present. Shortly after the dinners 118 of the guests were attacked with gastroenteritis, and all of these had eaten raw oysters. Twenty-one cases of typhoid fever, 5 of which were fatal, also developed as a result of eating the oysters.

Doctor Fraser reports an epidemic of typhoid fever at Portsmouth, where 25 persons were attacked with this disease after eating raw oysters.

In 1904 the following facts in regard to typhoid due to infected oysters were published in the fourth report of the commissioners of sewage disposal:

Doctor Nash, health officer at Southard-on-Sea, states that 50 per cent of the cases of enteric fever at that town were due to consumption of shellfish from sources contaminated by sewage. Out of 105 cases of that disease at least 85 bore some connection to polluted shellfish; also that the number of cases occurring at Yarmouth was greatly reduced after the sale of mussels was stopped in that town.

Doctor Newsholme, of Brighton, makes the following statement in regard to the cases of typhoid occurring in that city during the years 1894 to 1902: "There were 643 reported during this period; 158 cases were directly ascribable to the consumption of oysters and 80 to other shellfish. In other words, 37 per cent of the total number of cases is due to polluted shellfish." In the opinion of Doctor Newsholme the extent of the illness attributable to shellfish is probably understated.

Doctor Niven, of Manchester, reports 274 cases of typhoid out of 2,664 occurring in that city during the years 1897 to 1902, inclusive, as due to the consumption of shellfish.

Medical officers of London report that about 8 per cent of the cases occurring in London in 1902 were due to shellfish.

In 1895, stimulated by the interest awakened by the epidemic of typhoid fever at Wesleyan University, which Doctor Conn had shown to be due to infected oysters, Doctor Foote, of Yale, brought out the results of some bacteriological experiments on oysters. Though the aim of this work was to find out the length of time the typhoid bacillus could live in experimentally infected oysters, he states, with reference to the bacteriological content of oysters from presumably (?) uncontaminated sources, that no typhoid-like organisms were found in these specimens; the bacteria present in the juice were nearly all anaërobic micrococci. In another series of experiments he found *B. fluorescens liquefaciens* frequently in plates made from the juice, and in one instance *B. gasoformens*. He tested the stomach content of 9 oysters, and found that 8 were sterile. He isolated in these tests more than 10 varieties of bacteria, many of which were not identified, but none gave the reactions of the colon bacillus.

Doctor Giaxa states, however, that "it is a curious fact that in spite of the many varieties of bacteria found in the surrounding water, only two varieties (although in large numbers) could be detected in the oysters examined."

Chantemesse reports the presence of *B. coli* in many oysters from sewage-contaminated sources; also that oysters placed in water previously infected with typhoid stools for twenty hours contained these "typhoid organisms and *B. coli* in great numbers."

Dr. Cartwright Wood, in his work on the bacteriology of the oyster, did not succeed in finding pathogenic forms in shellfish taken from unpolluted sources. He also states that "all species of bacteria found in the juice are identical with the water bacteria found in the water in which the oysters live."

Sabatier, Duchany, and Petit isolated the following organisms from oysters: *Micrococcus fervidosus*, *M. flavus liquefaciens*, *M. radiatus*, *Bacillus fluorescens liquefaciens*, *B. mesentericus vulgatus*, *Streptothrix fœrsteri*, and *M. luteus*. On the other hand, no colon or typhoid bacilli were found by these observers in oysters "laid down" experimentally within a few feet of the outfall of a large sewer.

Herdman and Boyce, in England, were the next to direct their attention to the problem of oyster infection by sewage. They have shown that the presence of *B. coli* in oysters sold in the markets is by no means an unusual occurrence. In one series of experiments 48 batches of oysters were taken haphazard from the various fish markets of London. From "one-third to one-half of these specimens were found to contain *B. coli*," which was also found in a number of mussels, cockles, and periwinkles examined by them. *B. enteritidis sporogenes* was also found in oysters, mussels, and periwinkles. These observers are of

the opinion that the oyster "is more frequently liable to the presence of colon-like organisms than other species of common edible shellfish."

In 1901 Doctor Hill, of the Boston city health department, published the results of the analysis of clams obtained from the Charles River flats, which are exposed to contamination from the Boston sewage. These clams contained *B. coli*, *B. enteritidis sporogenes*, and *B. aerogenes capsulatus*.

In addition to the above list of experiments, a large number of references might be given to scattered outbreaks and sporadic cases of typhoid fever and gastro-enteritis which have been attributed to the ingestion of oysters and other shellfish. In most of these cases, however, no bacteriological examination of the material under suspicion was made, and therefore all evidence is purely circumstantial. For a comprehensive review of this literature the reader is referred to the article by Doctor Harrington, "Some reported cases of typhoid attributed to oysters," published in the Boston Medical and Surgical Journal, Vol. CXLIV, No. 19; to the exhaustive treatise of Doctor Mosny, "Maladies provoquées par l'ingestion des mollusques," in the Revue d'Hygiène, December, 1889, and January, February, and March, 1900; and to an article by Doctor Newsholme, published in the British Medical Journal of August 8, 1903.

Little success has attended the efforts to isolate the typhoid bacillus from contaminated oysters. Doctor Klein found it in but one of a large number of specimens examined. It was also reported in certain oysters from Constantinople. Many experiments have been made, however, to determine the conduct of *B. typhosus* in oysters experimentally inoculated with pure culture, and also to determine the length of time that the typhoid organism and the vibrio of cholera can live in sea water and in oysters and other shellfish. Indeed, much more attention has been given to this phase of the problem than to the bacteriology of normal oysters.

Whatever experiments have been made on normal oysters indicate that the bacterial content is variable, depending more or less on the locality from which the specimens are obtained. Nearly all observers agree that "normal" oysters—that is, oysters living in pure sea water—do not contain *B. coli* or other sewage forms "in their bodies or in the liquor within their shells," and that the bacteria occurring in these specimens are species commonly found in water. There is little doubt but that the germ content of the surrounding water determines, to a great extent, the germ content of oysters and other shellfish living in it. If *B. coli* and other sewage bacteria are present in appreciable numbers in the water we will in all probability find some trace of them in the shellfish. Doctor Houston, however, is of the opinion that *B. coli* is present in many shellfish from a presumably unpolluted source. In regard to the question as to whether the pres-

ence of *B. coli* in shellfish can be considered an index of fecal contamination there seems to be considerable difference of opinion. On the one hand Klein asserts this to be the case, and states that "the presence of *B. coli* in the oyster is strongly suggestive of fouling of the particular sample with material of excremental origin," while, on the other hand, Herdman and Boyce are inclined to accept the statement with reserve. From the results of the experiments recorded in this paper, however, it seems to me that the presence of this organism in oysters is a certain indication of sewage contamination.

It was partially due to the interest stimulated by the splendid paper on "Oysters and Disease," by Prof. W. A. Herdman and Rupert Boyce, of Liverpool, England, that the present investigations were undertaken. At that time the city of Providence was discharging, daily, large quantities of "untreated" sewage into the Providence River. It is in this body of water that most of the so-called "Providence River oysters" are raised for market. Besides the sewage of Providence, the drains of numerous summer residences and shore resorts located on the river banks also contribute to the general pollution of these waters, and the sewage of the city of Fall River is a possible source of contamination to certain oyster beds situated in Mount Hope Bay.

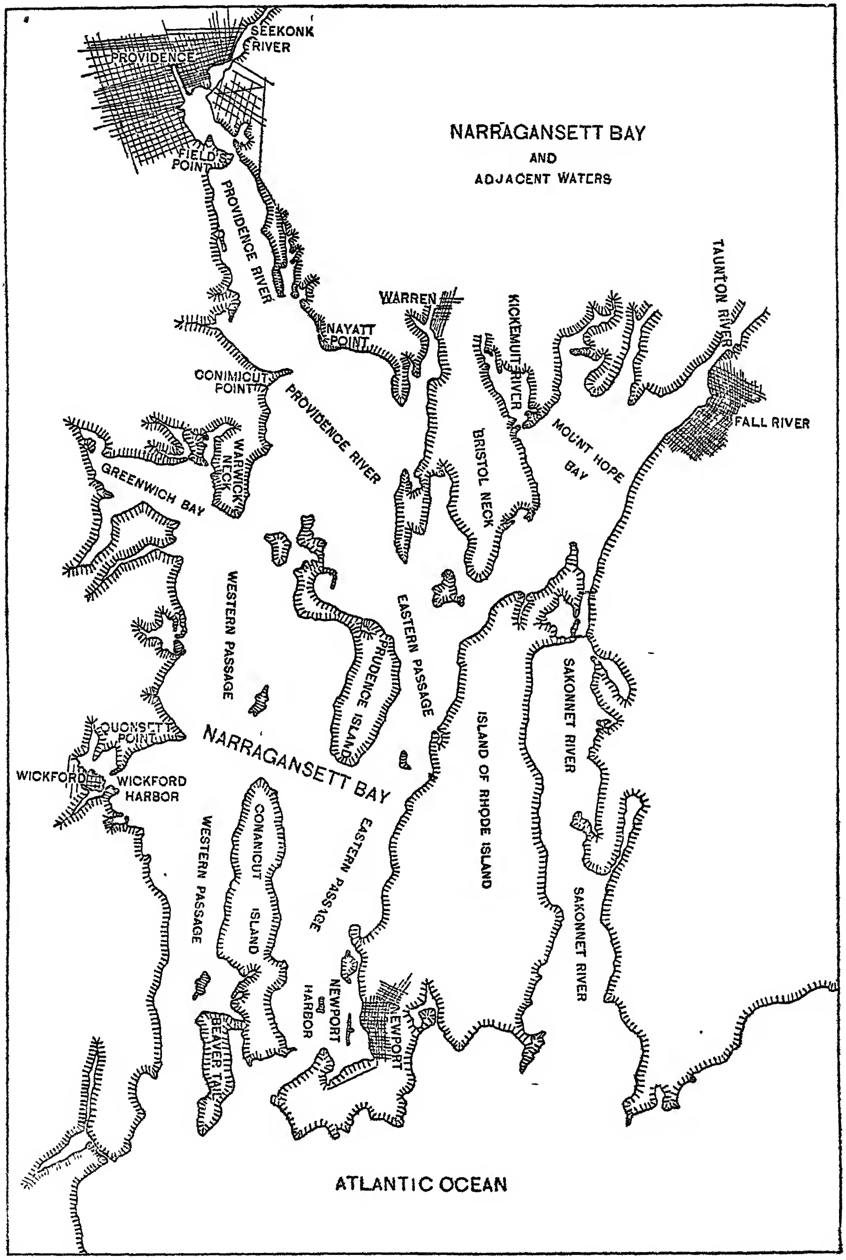
Here, then, was an interesting and practically unexplored field for research, the careful study of which might throw some light on the question of sewage pollution of tidal waters and the contamination of shellfish growing therein. The experiments were begun in the fall of 1899, and continued through a period of about three years. The end in view was twofold: First, to obtain by bacteriological examination some definite knowledge of the extent of the pollution of these waters, and, second, to determine, also by bacteriological methods, the presence of sewage in oysters and other shellfish from various regions of the bay. *Bacillus coli* was taken as an indicator of sewage pollution, and samples containing this organism were considered to be contaminated by sewage.

The work was carried on at the Anatomical Laboratory of Brown University, under the direction of Prof. F. P. Gorham, to whom I desire to express especial gratitude for assistance and guidance throughout the entire investigation. I wish also to express my sincere thanks to Dr. A. D. Mead, of Brown University, and to Dr. H. C. Bumpus, director of the American Museum of Natural History, for material assistance and many kindnesses shown me during the preparation of this work.

DESCRIPTION OF NARRAGANSETT BAY.

The state of Rhode Island has an actual land area of 1,054.6 square miles. The waters of Narragansett Bay, with its tributaries, comprise

an additional area of nearly 360 square miles, or more than one-fifth the total area of the state. Narragansett Bay proper is a narrow body



of salt water that makes into Rhode Island from the Atlantic Ocean, which washes the southern border of the state, as will be seen by

reference to the accompanying outline map of the inland waters of Rhode Island, and gives the locations of its principal seaport cities and towns. The bay has an irregular coast line, and reaches inland in a general northerly direction for a distance of 25 miles. Its greatest width is about 7 miles. Its western boundary is formed by the mainland of the state; its eastern shores by the mainland and the island of Rhode Island, which separates the bay from the Sakonnet River. The upper part of the bay is considerably narrower than the lower, or southern portion, and for a distance of about 10 miles is known as the Providence River. At the head of this river is the city of Providence, which, with the surrounding towns, has a population of some 200,000. The Providence River at this point is joined by the Seekonk, a brackish stream which rises in Massachusetts. From 3 to 4 miles above its union with the Providence River the Seekonk flows through the city of Pawtucket, a city of nearly 40,000 inhabitants. For a distance of 6 or 7 miles below Providence the Providence River barely exceeds a mile in width, and in some places is much less than a mile wide. After passing Conimicut Point, a narrow tongue of land which juts abruptly out from the western shore, the river rapidly broadens to nearly three times its former width. Near this point the larger river receives the Warren River, a little stream less than half a mile wide, interesting in the present connection in that it is used for oyster culture. The towns of Warren, having a population of 5,100, and Barrington, 1,135, are situated on the banks of this stream, about 2 miles from its union with the Providence River.

Conanicut and Prudence islands, lying near the mid line of the bay proper, divide it into two strips of water called the East and West passages, respectively. The two entrances into the bay from the ocean are separated from one another by Beaver Tail, the southern portion of Conanicut Island, which juts out into the mouth of the bay between the mainland and the southwestern extremity of the island of Rhode Island. Of these two approaches to the bay, the one leads directly into the Western Passage, the other into Newport Harbor and thence into the Eastern Passage. Proceeding northward, the West Passage broadens very gradually till it reaches Quonset Point. Under the lea of this land lies Wickford Harbor and the town of Wickford. There are small oyster beds planted in the sheltered water of Wickford Harbor. Six miles above Quonset Point the Western Passage breaks up into two channels, one leading to the northwest into Greenwich Bay, the other in a northeasterly direction into the Providence River.

The city of Newport is situated on the island of Rhode Island, near the entrance to the East Passage to Narragansett Bay. This city, of 22,034 inhabitants, is one of the two large ports in Rhode Island waters, but is not of moment in the present connection, since it is situated at a considerable distance from the oyster beds of the bay.

There is an open waterway from the East to the West passages, between Conanicut and Prudence islands. Between Prudence Island and the island of Rhode Island the East Passage has somewhat the shape of a long funnel, with the broad, open end directed up river. Bristol Neck reaches down into this wide opening, dividing the passage into two channels, one to the northwest becoming continuous with the Providence River, and one to the northeast leading into Mount Hope Bay, an irregularly shaped expanse of water, about 7 miles long and a little over 4 miles in its greatest width, which receives the Kickemuit River at its northwest corner and the Taunton River from the northeast. As has been already stated, it joins Narragansett Bay through the narrow passage between Bristol Neck and Bristol Ferry, and the Sakonnet River through a still narrower cut between Common Fence Point and the mainland. The city of Fall River, having a population of nearly 105,000, is situated on the southern shore of the Taunton River, near its junction with Mount Hope Bay. Though a city of Massachusetts, Fall River is of interest in this connection because it discharges its sewage into the Taunton River, so that it is possible that pollution from this source might reach the oyster beds in more or less distant parts of the bay.

The water of the lower or southern part of Narragansett Bay varies from 50 to 150 feet in depth. The shores are for the most part rocky, and drop abruptly from the water line to a considerable depth, forming no areas that could be of value in the cultivation of oysters. But a very different formation is found in the upper portion of the bay. The water is shallow, not over 30 feet in mid-channel, and the shores are low and reach out to the channel with a very long and gentle slope. As might be expected, here are many sand beaches and numerous shoals, with 6 to 18 feet of water upon them, making excellent grounds for clams, oysters, mussels, scallops, and other shellfish, which are found in abundance. It is estimated that there are some 6,000 acres of this ground in the upper bay suitable for the cultivation of oysters.

Being in direct communication with the sea, the waters of Narragansett Bay are kept in constant circulation by tidal currents, which reach inland beyond Providence to the north and Fall River to the eastward. There is a rise and fall, mean average tide, of 4 feet and 6 inches at the wharves of Providence, Fall River, and Newport. In some portions of the bay especially strong currents are caused by the formation of the land in the immediate neighborhood. Such currents may be found in the narrow entrance to Newport Harbor, in the entrance to Mount Hope Bay, and in the "cut" leading from Mount Hope Bay into the Sakonnet River, where very large volumes of water have to pass through narrow openings. Lesser currents, due to a like cause, are found in the Providence River between Conimicut and Nayatt points, at the head of the Western Passage of the bay between

Warwick Neck and Prudence Island, and in several other localities. A description of the bay would hardly be complete without mention of these tidal currents, since a number sweep directly over some of the oyster beds and carry with them whatever pollution may have entered the water.

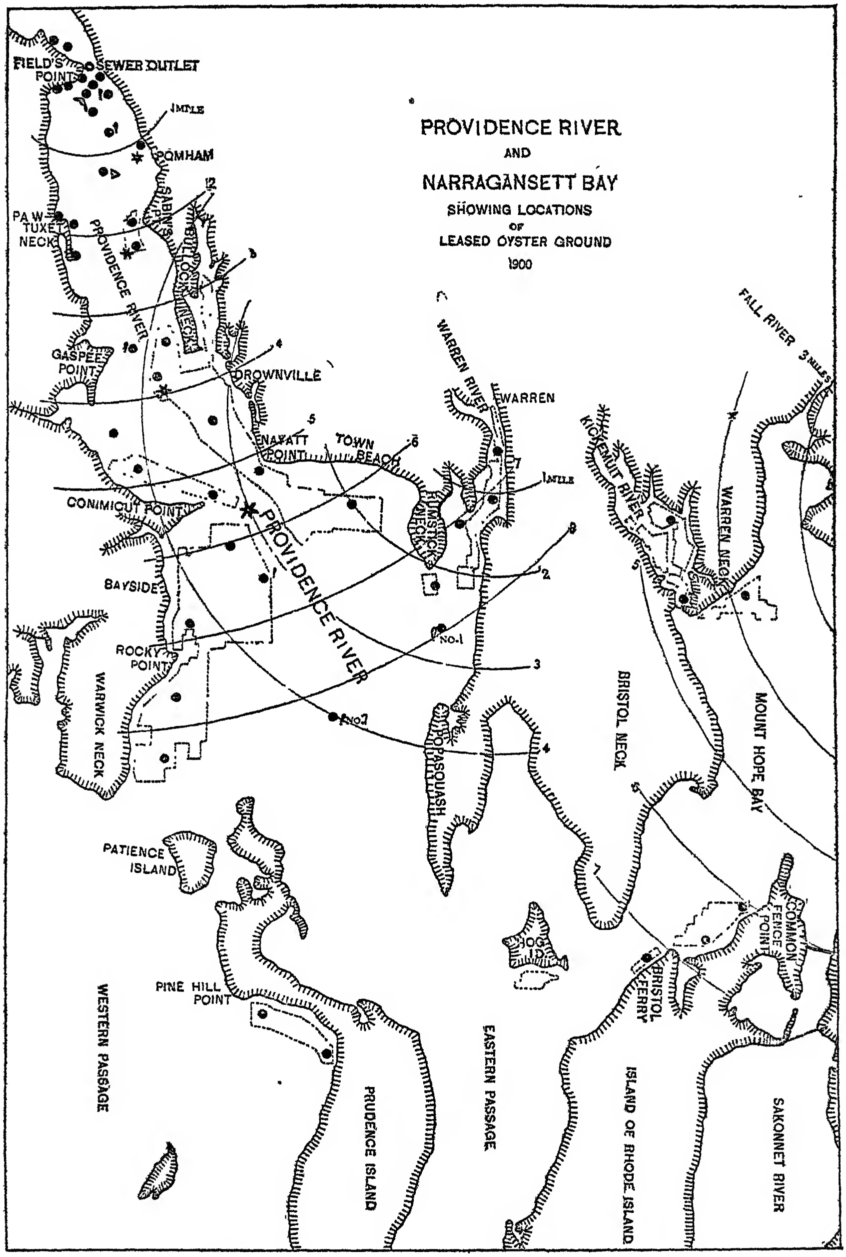
THE LOCATION OF THE LEASED OYSTER GROUND IN NARRAGANSETT BAY.

In the first annual report of the Commissioners of Shell Fisheries of Rhode Island it is stated that the income from the oyster ground leased in the Providence River during the year 1864 amounted to $61. In 1900 more than 3,000 acres of land in the Providence River and Narragansett Bay were devoted to this branch of industry, yielding an income of $25,000. The figures for the year 1903 show an increase of 2,000 acres in the total area leased in that year, with a rental increased to nearly $45,000.

The map on page 203 indicates the location of the leased oyster ground for 1900–1901, since the larger part of the oysters examined in this investigation were collected in the latter year. The areas occupied by the beds are outlined in dotted lines. It will be observed that the most extensive grounds are found in the Providence River rather than in the deeper waters of Narragansett Bay—in fact, there were but two oyster beds of any importance at this time in the bay proper. One was located in Wickford Harbor, 21 miles south of Providence; the second, under the western shore of Prudence Island, about 14 miles from the capital city. The Wickford layings, not represented on the map, comprise some five or six acres of land planted in 6 to 10 feet of water, in the direct path of a constantly flowing tidal current. No sewage is discharged into this body of water, so that the beds are free from local contamination. As will be seen by reference to the map, the Prudence Island beds are located south of Pine Hill Point, in a bend of the land formed by the irregular coast line of the island. They occupy an area of some 300 acres. There is a hard sand or gravel bottom in this locality, which is covered by from 10 to 15 feet of water at mean low tide. These beds are far removed from pollution of any sort, the nearest human habitation being at least 3 miles distant from this region.

As has already been stated, the most extensive oyster grounds are located in the Providence River. These are two large areas, over 1,000 acres each in extent, which lie between Warwick Neck and Bullock Neck. The first of these areas, known as the Rocky Point oyster beds, lies on the western side of the ship channel, and extends from near the southern shore of Warwick Neck northward to the southern boundary of Conimicut Point, the northern limit of the beds approaching to within 7¾ miles of Providence. These layings occupy a shoal that makes out from the western shore of the river, and is covered by water

varying in depth from 6 to 20 feet at low tide. Below Conimicut Point the river is fully 3 miles in width, and has free communication



with both the Eastern and Western passages of the bay, insuring a good circulation of water at all times; but above this point it is scarcely

a mile wide, and is an open body of water, unobstructed by islands or other land formation until it reaches Fields Point, 1¾ miles below Providence, where the sewage of the city is discharged into the river. Thus the second of these large areas lying on the eastern side of the channel reaches well up into this narrower section of the river. The southern layings of this area, the Nayatt oyster beds, are located south of Town Beach, well over toward Rumstick Neck, in the broader portion of the river, and from this region extend in a westerly direction around Nayatt Point, then, following the eastern shore, in a northerly direction to within 5¼ miles of the city. The northern section of the area is spoken of as the Bullock Neck oyster beds. While the southern sections lie in the more open water of the lower river, the northern limits are well up in the more confined waters of the upper river, therefore in the direct path of any contamination that may be borne downstream by the tides. (See map.)

Still another bed, of some 300 acres' extent, is located on the western side of the river, directly north of Conimicut Point, occupying a long narrow strip of land that extends from near the low tide limit to Conimicut Light, which marks the western boundary of the ship channel. It is about 7 miles distant from the city of Providence. The list of oyster grounds in the Providence River is completed with the description of a bed of about 125 acres, located on the eastern side of the river, directly off Sabins Point. As may be seen by reference to the map, this bed is but 3 miles below the city limits.

Before leaving the neighborhood of the river, however, the beds in the Warren River must be mentioned. In 1900 extensive layings of oysters were made in and about the entrance of this stream. Near the mouth, they were confined to the shoal water on either side of the channel, but a short distance above this section they occupied both channel and shoal water, so that the bottom of the river was a continuous oyster bed from near its junction with the Providence River to the town of Warren, 2 miles inland.

The five remaining oyster beds located in Rhode Island waters are found in or near Mount Hope Bay. The first of these is planted on a shoal directly south of Hog Island, which is less than a mile from the entrance of the bay; the second is a much smaller area off Bristol Ferry, in the narrow entrance to the bay; the third and largest area lies to the east of Bristol Ferry, off Common Fence Point; the fourth, 3 miles distant from the last-mentioned bed, in the northwestern corner of the bay, south of Warren Neck; and the fifth, around Warren Neck, in the Kickemuit River. The beds off Warren Neck are 4 miles from the city of Fall River; those at the entrance of the bay, 7 miles. Thus it may be noted that these grounds are situated at a considerable distance from the discharge of the Fall River sewer. The beds in the entrance of the bay are also scoured by very strong tidal currents, due to causes already explained.

THE SOURCES OF SEWAGE POLLUTION OF NARRAGANSETT BAY.

The sewage of the city of Providence and immediate neighborhood is collected at the sewage pumping station at Fields Point, about 1¾ miles below the city, and is discharged into the river through a single large main. The outlet of this drain is indicated on the map on page 203. Though it is covered by 25 feet of water at low tide, it may be readily located on a calm day by the greasy, turbid stream of sewage which rises rapidly to the surface of the water at that point.

In 1900 an average amount of nearly 14,000,000 gallons of sewage was daily pumped into the river through the Fields Point sewer, and at that time was thrown into the river in a "crude" or "untreated" state; that is, it was simply passed through a screen to remove the solid matters before being sent on to the outfall pipe. The screen consisted of a rack or frame of parallel iron rods placed about an inch apart, and was set at an angle of about 20 degrees from the perpendicular. The stream of sewage was allowed to flow through this apparatus, and whatever constituents were too bulky to pass through the grating were scraped off with a rake and otherwise disposed of; but, as might be expected, considerable amounts of solid matter slipped through, and the beaches within half a mile of the outlet were strewn with this refuse.

Before these investigations were completed, however, the city put in operation a sewage disposal plant at the Fields Point Station. After screening, as already described, the sewage is subjected to the action of sulphate of iron and chloride of lime, which process causes about 50 per cent of the total solids then in suspension to precipitate out and sink to the bottoms of large reservoirs in which the sewage is allowed to remain for twenty-four hours. The clearer fluid is then drawn off and turned into the river, while the "sludge" which remains on the bottom of the basin is strewn over the land. Before this method was employed the gray scum from this sewer could often be traced on the surface of the water several miles below Fields Point, where it had been carried by tidal currents. The station has one other large outlet, the "storm" sewer, which opens into the river from the northern shore of the point. This sewer is a culvert built in the form of an arch, which is entirely out of water at low tide. It is used only in case of accident to the large main or during heavy rain storms, when 20,000,000 and sometimes 25,000,000 gallons are discharged in twenty-four hours.

Two other small overflow sewers help to drain the east side of the city, pipes discharging into the Seekonk River between Red Bridge and Washington Bridge. The sewage from these drains, together with that of the city of Pawtucket, situated on this same stream 3 miles above Providence, and the waste from the various mills along the banks of the river pass down the Seekonk into the head of the Providence

River. Also, since Providence and Pawtucket are manufacturing centers, a large amount of waste from gold and silver refineries, from bleacheries and dye houses, and coal tar products from the gas companies' plants, ultimately find their way into the river.

In addition to these more important sources of pollution, the drains from numerous shore resorts and summer residences situated on the river banks must be named as a secondary source of contamination. These drains are of minor importance in the general contamination of the water, since the amount of sewage discharged by them is small in comparison with that already mentioned, and also because they are in use but a few months during each season, and at a time when few oysters are dredged for market.

The section of the river which receives this large amount of sewage is a strip of water a little over 5 miles long, varying from about 1 mile to 1¼ miles in width. As has already been pointed out, the tide reaches well up into the river past Providence and up the Seekonk River nearly to Pawtucket. Thus twice in every twenty-four hours clean sea water from the bay below flows toward the polluted areas, and is a very important factor in the purification of the river.

Much more space has been devoted to the description of the conditions in the Providence River than will be given to the other waters of the bay, because this river is more polluted by sewage, and because most of the oyster ground of Rhode Island waters is located in this body of water. The pollution of the Warren River is of only local importance, since it is soon swallowed up in the large volume of fresh sea water it encounters when this stream joins the Providence River. The contamination of the Warren River is due chiefly to mill waste and to the sewage from a few private drains that discharge into the river.

The sewage of Fall River is the third factor in the pollution of the bay. This waste is discharged into the Taunton River near the head of Mount Hope Bay. The outfall of this sewer is, of course, at a considerable distance from the Providence River and Narragansett Bay, and even though a large quantity of sewage and mill waste is passed into the Taunton River, all visible evidence of pollution has disappeared from the water at the entrance of Mount Hope Bay, nearly 7 miles distant from the sewer outfalls.

These three sources, then—the Providence sewers, the Warren mill waste, and the Fall River sewers—are the principal ones from which contamination can be spread to the oyster beds of the river and bay. The sewage from Newport never reaches the oyster beds, the nearest of which are at least 12 miles above Newport Harbor.

BACTERIOLOGICAL ANALYSIS OF WATER SAMPLES FROM NARRAGANSETT BAY.

Methods employed.—The usual methods for isolation of *B. coli* from water and sewage were used in this work. Fermentation tubes containing a neutral 1 per cent dextrose broth were inoculated with 1 c. c. of the suspected water and incubated for three days at 37° C. In some cases a 0.1 per cent phenol broth was also inoculated with 1 c. c. of the water and allowed to develop at 37° C. for twenty-four hours. In a few tests litmus-lactose-agar and agar containing 1 per cent neutral red were sown with varying amounts of water and grown at incubator temperature.

If no gas was formed in the fermentation tubes in twenty-four hours the test was considered negative without further procedure. If, however, any considerable quantity of gas developed within this time, litmus-lactose-agar plates were inoculated in most cases from these tubes and incubated at 37° C. twenty-four hours longer. When litmus-agar plates were not used, a gelatin medium was substituted. Any red colonies developing on the litmus medium, and any colonies showing the characteristic growth of *B. coli* on gelatin, were fished out and transferred to slant agar tubes. From the cultures thus obtained subcultures were made in neutral dextrose and lactose broth, nitrate solution, milk, sugar-free broth containing 2 per cent of peptone and gelatin. When growth occurred in the phenol broth, although sufficient gas to indicate the presence of *B. coli* was not developed in the fermentation tubes, litmus-lactose-agar plates were inoculated from the phenol broth and treated as already described.

Organisms giving the following positive reactions to tests were regarded as members of the colon group of bacteria:

1. A small more or less motile bacillus in twenty-four-hour bouillon or agar cultures. Usually not all the bacilli in one microscopic field are motile—often sluggishly motile.

2. Fermenting dextrose broth with the production of gas. The large part, if not all, of the gas is formed during the first twenty-four hours. The liquid in the tube must be distinctly acid to indicate *B. coli*. The ratio of hydrogen to carbon dioxide is approximately 2 to 1. This ratio is, however, more or less variable in cultures from a single strain. The total amount of gas produced in dextrose usually does not exceed 55 per cent, though there is also more or less variation in this characteristic.

3. Fermenting lactose with the production of much gas; reaction strongly acid.

4. Indol produced in sugar-free broth containing 2 per cent of peptone.

5. Milk coagulated in three days at room temperature; in twenty-four hours at 37.5° C.; casein not liquefied; reaction acid.

6. Gelatin not liquefied; stab cultures and plate cultures give characteristic growths.

7. Nitrates reduced to nitrites.

Bacterium lactis aerogenes is a closely allied form, but differs from *B. coli* in that it is nonmotile; it produces larger amounts of gas in dextrose broth (75 per cent), and it does not produce indol. It is nonpathogenic.

B. cloacæ also produces large quantities of gas in dextrose bouillon (from 65 to 75 per cent). It liquefies gelatin, casein, and blood serum, and produces indol and nitrates.

Samples of water to be tested were collected in sterile 25 c. c. tubes by means of an apparatus similar to that suggested by Professor Bolley for use in deep wells. The tubes were made from large 8-inch test tubes by drawing out slightly in a Bunsen flame the open end of the tube, bending the lengthened portion to a right angle with the rest, and finally drawing it out into a fine capillary tube. These tubes were sterilized, and after a partial vacuum had been secured by heating, the fine tube was sealed in a flame. A rack holding 20 of these tubes was easily carried in a small grip. The collecting apparatus consisted of a solid block of brass 9 inches long by 1½ inches wide by three-fourths inch thick, against the flat side of which the tube was firmly held by two sets of clamps, the sealed capillary tube passing through a hole bored in the upper end of the block. In collecting the water samples the apparatus was lowered by a stout cord to the desired depth and the sealed tube broken by a metal slide, which was operated by allowing a weight to run down the line on which the apparatus was lowered. The partial vacuum in the tubes usually filled them one-half to three-fourths full of water. These tubes were again placed in the rack and carried to the laboratory unsealed, for a length of the bent tube sufficient to protect the sample from outside contamination usually remained after the sample had been collected. When the tubes reached the laboratory, at no more than four or five hours after collection of the water samples, the tops were passed through a flame and enough of the glass broken away with sterile forceps to allow the entrance into the tube of a sterile 1 c. c. pipette. Samples were immediately transferred from these tubes to the different culture media, as already described.

When samples were taken in deep water, two collections were usually made at each locality visited, one a foot below the surface of the water and a second a foot off the bottom of the river. In the shallow water near the shores samples were collected by plunging sterile bottles below the surface of the water. In examining clam flats and mussel beds left uncovered by the tide, samples of sand and mud were collected at low tide and samples of the water covering these grounds on the flood tide.

Results.—The bacteriological examination of any large body of water resolves itself into an analysis of series of samples taken from various sections of the stream. So in this survey of the Providence River collections were made first at the head of the river, then, proceeding downstream, at intervals of varying distance until the polluted area was passed. For the sake of brevity, the localities at which collections were made will be spoken of hereafter as "stations," and they have been indicated on the map by large dots. When possible, they were chosen near some prominent landmark, so that they might be more easily found a second time, since in many instances several trips were made in order to observe the effect of varying conditions of tide and weather.

The evidences of sewage pollution of both the water and shore in the neighborhood of Fields Point were very obvious. Below the point the west bank of the river falls abruptly away from the eastern shore, taking a westerly direction for nearly half a mile, when it again resumes its general southerly course. The deep water of the river follows closely the eastern shore, so that a large area of shoal water is formed south of Fields Point, extending out beyond Starve Goat Island. This section of the river is therefore out of the direct tide current, which naturally follows the channel along the east shore, and the water is consequently rather sluggish. It is a dirty gray color, which is due to the large amounts of sediment in suspension. Also the beaches within a quarter of a mile of the sewer outfall are usually covered with foul-smelling slime and collections of sewage refuse, left there by the receding tide water. Before the Fields Point sewage station was put into operation this shoal was a famous natural oyster bed, but it has been abandoned for a number of years. At the present time quantities of seed oysters are taken from this locality in the spring of the year and planted on beds farther down the river. The beaches in this neighborhood also produced an abundance of clams.

In the section of the river above described the first series of water samples was collected at 11 stations situated in an area at no point more than half a mile distant from the outlet of the main sewer. Commencing on the northern shore of Fields Point, these stations were located as follows: Station 1, halfway between the ship channel and the northern shore of the point, directly off the outfall of the "storm" sewer; station 2, off the end of the steamboat landing; station 3, directly over the outlet of the main sewer; stations 4 and 5, in deep water on opposite sides of the channel, a short distance below the point; stations 6, 7, and 8, in the shallow water on the flats running out from the southern shore of the point; stations 9 and 10, in about 10 feet of water near Starve Goat Island, and station 11, in the ship channel just off buoy No. 11. Perhaps the exact situations can

be better understood by reference to the map. Two trips were made to these localities during the winter and spring of 1901, and three more stations were located about this time in the river near Pomham—one west of the ship channel, close by buoy No. 9; another on the eastern side of the channel, directly north of Pomham Light, and a third in the more shoal water to the west of Pomham Beacon, which is about 1¼ miles below Fields Point. Three trips were made to the stations. The results of the analyses of the samples are arranged in the accompanying tables.

TABLE I.—*Analysis of water samples collected in the neighborhood of Fields Point.*

Date and station.	Dextrose, fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
January 15, 1901, tide rising three-fourths high; wind fresh SW.				
Station 1, surface tube	+	+	+	+
deep tube	+	+	+	....
deep tube	+	....	....	....
2, surface tube	+	(a)	+	....
deep tube	+	+	+	+
3, surface tube	+	+	+	+
deep tube	+	+	+	....
4, surface tube	+	+	+	+
deep tube	+	+	+	....
5, surface tube	+	+	+	+
deep tube	+	+	+	+
6	+	(a)	+	+
7	+	+	+	+
8	+	+	+	....
January 29, tide rising; one-half mile from sewer.				
Station 9, surface tube	+	+	+	+
deep tube	+	+	+	....
10, surface tube	+	+	+	....
deep tube	+	+	+	....
11, surface tube	+	+	+	....
deep tube	+	+	+	....
April 10, low tide.				
Station 1, surface tube	+	+	+	+
deep tube	+	−	−	+
2, surface tube	+	+	+	....
deep tube	+	+	+	....
3, surface tube	+	+	+	....
4, surface tube	+	+	+	....
deep tube	−	−	−	....
5, surface tube	+	+	+	....
deep tube	+	(a)	+	....
6	+	+	+	....
7	+	+	+	+
8	+	+	+	+
April 24, low tide.				
Station 9, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
10, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
11, surface tube	+	+	+	....
deep tube	+	−	−	....

a Not made.

TABLE II.—*Analysis of water samples collected off Pomham.*

Date and station.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
February 26, flood tide.				
Station 1, surface tube	+	+	+	+
deep tube	+	+	+	+
2, surface tube	+	+	−	+
deep tube	+	+	+	....
3, surface tube	+	+	+	....
deep tube	+	+	+	....
March 2, tide falling.				
Station 1, surface tube	+	+	+	....
deep tube	−	−	−	....
2, surface tube	+	(a)	+	....
deep tube	+	+	+	....
3, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
March —, tide falling.				
Station 1, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
2, surface tube	+	+	+	....
deep tube	+	−	−	+
3, surface tube	+	+	+	+
deep tube	+	+	+	+

[a] Not made.

The data given in Tables I and II show clearly that the water of the river in the immediate neighborhood of Fields Point and also at Pomham, 1¼ miles below this point, is polluted by sewage to a very considerable extent, since it is possible to isolate *B. coli* from practically every sample collected within this area. This statement seems to be trustworthy whether the tide is making upstream or falling, or whether the samples are collected when there is a stiff breeze from the southerly direction, thus tending to drive an increased amount of water up the river, or during a flat calm.

An attempt to estimate the number of bacteria per cubic centimeter in the water about Fields Point was made by inoculating nutrient gelatin plates from two of the samples collected April 10 and keeping them three days at room temperature. Four plates were made from each sample, and the average count of colonies developing was estimated as follows: Station 2, surface water, 1,500,000 bacteria per cubic centimeter; station 3, surface water, 2,000,000 bacteria per cubic centimeter. Thus the quantitative as well as qualitative analysis points to high organic pollution of these waters.

The second series of samples was collected from a section of the river from 2 to 2½ miles from Fields Point. These samples were taken at five stations, as follows: Station 1 over the northern part and station 2 at the southern end of the oyster grounds off Sabins Point; on the Pawtuxet shore, station 3 in the shallow water covering the sand beach west of the Rhode Island Yacht Club house, station 4 off the end of the club wharf, and station 5 in shallow water again, from the shore near the end of Pawtuxet Neck. Four trips were made to the first two of these stations; but one to those on the western shore of the river. The result of these analyses is included in Table III.

TABLE III.—*Analysis of water samples collected off Pawtuxet Neck and over the Sabins Point oyster beds.*

Date and station.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
March 18, tide falling.				
Station 1, surface tube	+	+	+	.....
deep tube	+	+	+	.....
2, surface tube	+	+	+	.....
deep tube	+	?	?	.....
March 19, tide falling.				
Station 1, surface tube	+	(a)	+	.....
deep tube	+	(a)	+	.....
2, deep tube	+	(a)	+	.....
April 10, tide falling.				
Station 1, surface tube	+	(a)	+	.....
deep tube	+	(a)	?	.....
2, deep tube	+	.....	−	.....
April 17, tide rising, near flood.				
Station 1, surface tube	+	(a)	+	+
deep tube	−	+	−	.....
2, surface tube	+	+	−	.....
deep tube	−	(a)	−	.....
March 27, low tide.				
Station 3	+	+	+	+
4	+	+	+	.....
5	+	+	+	+

a Not made.

In this section of the river the water is apparently much cleaner along the eastern shore over the oyster bed, while the condition on the Pawtuxet shore was evidently so bad that only one collection of samples was made at this point. Still, analysis of samples from stations 1 and 2 showed that *B. coli* was usually present in the water through this section of the river, at least during a falling tide, though only one of the four samples taken April 17 was found to be contaminated. It must be remembered, however, that these samples were taken at flood—the time, if ever, that the river will be free from pollution.

A mile and a half below the Sabins Point ground are found the northern limits of the extensive Bullock Neck beds. No samples were collected in that portion of the river between these beds, but five stations were located below this point over the oyster bed that extends along the eastern shore, past Drownville and Nayatt Point to Town Beach, and four on the western side of the river. These stations were located as follows: Station 1, at the northern end of the Bullock Neck oyster bed, 3½ miles below Fields Point; station 2, to the north of Bullock Point Light; station 3, off the Drownville shore, 4½ miles from the sewer outlet; station 4, directly south of Nayatt Point; and station 5, on the southern portion of these oyster layings, well over toward Rumstick Point. On the western side of the river, station 6 was placed at buoy No. 3; station 7, at buoy No. 1; and stations 8 and 9 over the oyster beds off the north shore of Conimicut Point. Sev-

eral trips were made to this section in the spring and fall of 1901. The results obtained from the analysis of the samples may be tabulated as follows:

TABLE IV.—*Analysis of water samples collected on the Bullock Neck, Nayatt Point, and Conimicut Point oyster beds.*

Date and station.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
March 30, tide rising.				
Station 1, surface tube	+	+	+	....
deep tube	−	−	−	....
2, surface tube	+	+	−	....
deep tube	+	+	+	....
3, surface tube	+	+	−	....
deep tube	+	+	−	....
6, surface tube	+	(a)	+	....
deep tube	+	+	−	+
7, surface tube	−	+	−	....
deep tube	+	+	+	....
May 2, tide falling.				
Station 1, surface tube	+	+	+	....
deep tube	−	+	−	....
2, surface tube	+	(a)	+	....
deep tube	+	+	+	....
3, surface tube	+	+	−	....
deep tube	+	+	+	....
May 15, tide falling.				
Station 1, surface tube	+	+	+	....
deep tube	+	+	+	....
2, surface tube	+	+	+	....
deep tube	−	+	−	....
3, surface tube	+	+	+	....
deep tube	+	+	+	....
4, surface tube	+	−	−	....
deep tube	+	+	−	....
5, surface tube	−	+	−	....
deep tube	+	+	+	....
October 11, tide rising.				
Station 8, surface tube	+	+	−	....
deep tube	+	+	+	....
9, surface tube	+	+	−	....
deep tube	−	−	−	....
October 24, tide rising.				
Station 4, surface tube	+	+	+	....
deep tube	−	+	−	....
5, surface tube	+	+	−	....
deep tube	+	+	−	....
8, surface tube	+	(a)	+	....
deep tube	−	+	−	....
9, surface tube	−	+	−	....
deep tube	−	−	−	....
October 29, tide falling.				
Station 4, surface tube	+	−	−	....
deep tube	+	(a)	+	....
5, surface tube	+	+	−	....
deep tube	−	−	−	....
8, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
9, surface tube	+	(a)	+	....
deep tube	+	(a)	+	....
November 3, tide rising.				
Station 4, surface tube	+	+	+	....
deep tube	−	+	−	....
5, surface tube	+	+	+	....
deep tube	−	−	−	....
8, surface tube	+	+	+	....
deep tube	+	+	−	....
9, surface tube	+	(a)	+	....
deep tube	−	+	−	....

a Not made.

Though the river below Bullock Neck does not have the appearance of a sewage-polluted stream, it is possible to isolate *B. coli* from some samples of water taken from it. A smaller percentage of the samples collected about Conimicut and Nayatt points than of those collected nearer the sewer outlet give tests for this organism; it was found in 59 per cent of the water samples taken in the neighborhood of Bullock Neck; in 50 per cent of those collected over the Conimicut beds; and in but 31 per cent of those obtained from the Nayatt ground. It is very evident that the tides play an important part in the purification of this section of the river. Most of the samples which gave positive reactions for *B. coli* were collected on a falling tide. Samples taken on the flood are, in many cases, free from sewage bacteria.

Here, then, is an area from 3 to 6 miles distant from the chief sources of pollution, in which the sewage, when present, is diluted to such an extent that examination often fails to reveal the presence of fecal bacteria in 1 c. c. samples.

Below Conimicut Point, in the broader expanse of the lower river, five stations were located over the extensive Rocky Point oyster ground. These were situated as follows: Station 1, over the northern portion of these grounds, 6 miles below Fields Point; station 2, about half a mile farther south, near channel buoy No. 9; station 3, just north of Rocky Point; station 4, south of Rocky Point; and station 5, over the southern areas of this ground, which is about 8½ miles south of the Fields Point sewer outlet.

A single trip was made to the Warren River in October, 1902, and samples collected at five stations about half a mile apart. Station 1 was located at buoy No. 1, marking the entrance to Warren River channel, which is in reality in the Providence River, about half a mile directly south of Rumstick Neck; station 2 directly in the entrance to the Warren River, half a mile above station 1, and so on up the river. At this time samples were collected at a station, No. 6, in Providence River, located at buoy No. 7. These samples were taken because this locality is swept by any tidal currents that may come from the Warren River on ebb tide, and it was desired to ascertain whether pollution from this stream was noticeable in the Providence River at that point. Tables V and VI give in condensed form the results of the analysis.

TABLE V.—*Analysis of water samples collected over the Rocky Point oyster ground.*

Date and station.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
October 10, 1901, tide rising.				
Station 1, surface tube	−	−	−	...
deep tube	+	−	−	...
2, surface tube	−	−	−	...
deep tube	−	+	−	...
3, surface tube	+	+	−	...
deep tube	−	−	−	...
4, surface tube	−	−	−	...
deep tube	−	−	−	...
5, surface tube	−	+	−	...
deep tube	−	−	−	...
October 19, tide falling (very low).				
Station 1, surface tube	+	+	+	...
deep tube	+	−	−	...
2, surface tube	+	+	−	...
deep tube	−	+	−	...
3, surface tube	−	−	+	...
deep tube	−	+	+	...
4, surface tube	−	+	−	...
deep tube	−	−	−	...
5 surface tube	+	−	−	...
deep tube	+	+	−	...
November —, 1901, tide falling.				
Station 1, deep tube	−	−	−	...
2, deep tube	+	+	−	...
3, deep tube	−	−	−	...
4, deep tube	−	−	−	...
5, deep tube	−	−	−	...

TABLE VI.—*Analysis of water samples collected in Warren River.*

Date and station.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
October 8, 1902, tide falling.				
Station 1, surface tube	+	(a)	+	...
deep tube	+	(a)	+	...
2, deep tube	+	(a)	+	...
3, deep tube	+	(a)	+	...
4, deep tube	+	(a)	+	...
5, surface tube	+	+	+	...
deep tube	−	−	−	...
6, surface tube	−	+	−	...
deep tube	−	−	−	...

a Not made.

From the above data it is apparent that the river after passing Conimicut Point is comparatively free from sewage. *B. coli* was found in only two samples taken from this section, once in a sample from station 1 and in one sample from station 3; both these samples were collected at a very low tide, due to the change of moon. On the other hand, it will be noticed that nearly all the samples from the Warren River gave tests of *B. coli*, but after the Warren River joins the Providence River this organism soon disappears from the water.

Thus between 6 and 7 miles below the Fields Point sewer is another area of water from which nearly all traces of pollution have dis-

appeared. *B. coli* is found only occasionally, and then on the ebb tide. Another zone of pollution spreads out from Warren River, however, and at station 1, buoy No. 1, 3 miles below the town of Warren, evidences of it can be discovered; but at station 6, 4 miles below this town, examination fails to reveal the presence of sewage bacteria. Samples from the Prudence Island and Wickford oyster beds contained no colon bacilli; neither did the samples collected over the southern parts of the Rocky Point oyster ground, so that the Providence River, 8 miles below the chief sources of contamination, ceases to be a polluted stream. If sewage is present in the water below this point, it is in too great dilutions to be recognized in the 1 c. c. samples that were used in this work. The waters of Narragansett Bay are also free from sewage pollution.

The next series of samples was collected in or near the Kickemuit River. Three stations were located in this part of the bay: Station 1, over the oyster layings south of Warren Neck; station 2, just inside the mouth of the Kickemuit River; and station 3, about three-quarters of a mile farther up the river. *B. coli* was found in but one sample from the oyster beds south of Warren Neck, which are 4 miles from the Fall River sewer. Finally, three stations near the entrance to Mount Hope Bay were visited—stations 1 and 2, over the oyster bed north of Common Fence Point, 6 and 6¾ miles, respectively, from Fall River; and station 3, over the Bristol Ferry bed, 7¼ miles below the city. But a single sample contained the colon bacillus. This was collected at station 3, off Bristol Ferry, and the presence of the organism was probably due to some local contamination rather than to the sewage from Fall River, since samples from stations 1 and 2, considerably nearer the chief source of pollution, did not contain this bacillus.

As a final test of the distribution of sewage bacteria in the river, an attempt was made to estimate the number of colon bacilli per cubic centimeter in this water. For this test lactose agar plates containing 1 per cent neutral red were inoculated directly with the water to be tested, and incubated forty-eight hours at 42° C. After this period, the colonies developing were examined, and those exhibiting the characteristic appearance of *B. coli* on this medium were counted. It was impossible to study each separate colony in pure culture, therefore these figures have but an approximate value. Four plates were made from each sample; and the figures given in Table VII represent the average number of characteristic colonies developing within the given time. The samples used in this test were collected (October 21, 1901, tide rising) at the stations indicated on the map on page 203. The first sample was taken near the sewer outfall at Fields Point; the others at places farther down the river.

TABLE VII.—*Quantitative analysis of water samples collected in Providence River.*

Locality.	B. coli per cubic centimeter in river water.	Locality.	B. coli per cubic centimeter in river water.
Fields Point:		Bullock Neck:	
Station 3, surface tube	96	Station 7, surface tube	2
deep tube	(?)	deep tube	6
9, surface tube	450	4, surface tube	3
deep tube	500	deep tube	2
10, surface tube	200	5, surface tube	0
deep tube	50	deep tube	0
Pomham:		8, surface tube	1
Station 1, surface tube	75	deep tube	0
deep tube	14	Rocky Point:	
3, surface tube	9	Station 1, surface tube	0
deep tube	14	deep tube	0
Bullock Neck:		2, surface tube	0
Station 2, surface tube	24	deep tube	0
deep tube	0	3, surface tube	0
6, surface tube	20	deep tube	0
deep tube	6		

Though the results obtained by this method are by no means as accurate as might be desired, nevertheless they indicate, as has already been proved, a gradual decrease in the amount of pollution in the river as it reaches down toward the headwaters of Narragansett Bay.

The data obtained by the analysis of the foregoing water samples may be summed up as follows: The Providence River above Conimicut Point is a sewage-polluted body of water, but below this point the water of the river and the headwaters of Narragansett Bay are free from contamination. The presence of sewage may also be detected in Warren River. That section of Mount Hope Bay in which the oyster ground is situated appears to be entirely free from pollution.

The distribution of sewage in Rhode Island waters, as indicated by the presence of *B. coli* in water samples, may be readily traced from the principal sources of contamination. As has already been stated, these are three in number—the Providence sewage, Warren mill waste, and the sewage from Fall River. Referring once more to the map on page 203, it will be observed that equidistant concentric lines radiating from three different centers have been drawn across the areas representing the Providence River, the Warren River, and Mount Hope Bay. The space between these lines represents 1 mile actual distance. The series of arcs which divide the Providence River into sectors are drawn using the point at which the outlet of the Fields Point sewer is represented as a center, and with their aid the distribution of sewage in the river may be traced as follows:

The water of the river in the sector included within the arc of the first circle, at no point more than 1 mile distant from Fields Point, is highly polluted. Samples taken from this portion of the river contain *B. coli* and other fecal bacteria under all conditions of tide and weather.

These organisms are also found in the majority of samples collected 2 miles below the sewer outlet. About 74 per cent of these samples contained *B. coli*.

The section of the river 2 to 4 miles below the chief source of contamination is much freer from pollution. *B. coli* was found in 59 per cent of the samples from this area, and the majority of positive tests was obtained from samples collected at low water, while many samples taken on the flood tide did not contain fecal bacteria of any sort.

Five miles below Fields Point, still fewer samples contain *B. coli*; 6 miles below this organism is rarely found. About 50 per cent of the samples from the Conimicut Point oyster beds and about 31 per cent of those from the Nayatt Point ground contained colon bacilli. The eastern shore of the river is cleaner than the western above Conimicut Point. Below this point reverse conditions are encountered. No fecal bacteria were found in samples collected on the Rocky Point oyster ground, over 7 miles distant from Fields Point.

But *B. coli* was isolated from samples taken near buoy No. 1, marking the entrance of the Warren River channel. This station is a little over 2½ miles distant from the town of Warren, and at the same time is far enough out in the Providence River to be just included in the arc which marks the 8-mile limit from Fields Point. No fecal bacteria were found in samples collected near buoy No. 7, however, which is 4 miles distant from Warren and about 8½ from the Providence sewer outlet. Thus it may be stated that 8 miles below the Fields Point sewer no colon bacilli have been found in the water of the river, and from this point on till it reaches the headwaters of Narragansett Bay the river is free from sewage bacteria.

Passing downstream, the number of colon bacilli in the river water decreases gradually from 500 per cubic centimeter one-half mile below Fields Point to 1 per cubic centimeter at Conimicut. Below Conimicut no sewage bacteria were found by the plate method employed in this test.

The water on the Prudence Island and Wickford oyster beds does not contain *B. coli*.

The portion of Mount Hope Bay included in the Rhode Island territory is comparatively free from pollution, and the oyster ground in this bay is located from 4 to 7 miles below Fall River, the chief source of pollution. *B. coli* was isolated from a single sample taken in the entrance to the bay, but the presence of the organism in this instance was probably due to local contamination, for other samples taken near by did not give reactions for colon bacteria.

Samples from Kickemuit River did not contain *B. coli*.

One sample collected on the oyster bed under Warren Neck contained *B. coli*.

BACTERIOLOGICAL ANALYSIS OF SHELLFISH FROM NARRAGANSETT BAY.

Methods employed.—Much the same plan of work was employed in the examination of the shellfish of Narragansett Bay as was used in the water analysis. Oysters, clams, and mussels were first collected on the

beaches near the Fields Point sewer outlet and later at various other localities in the river and bay. In the examination, inoculations were made from the liquor contained between the shells, from the contents of the intestines, stomach, and rectum, and in some cases from portions of the visceral mass. In order to obtain samples of the juice from an oyster under aseptic conditions, the specimens to be examined were scrubbed thoroughly in tap water with a stiff brush, washed off in running sterile water, and dried on a sterile towel, after which they were opened with a sterile knife. To obtain cultures from the stomach, the top of the mantle covering the anterior end of the oyster was slit open and the large palps on either side of the mouth pushed aside; the mouth region was sterilized by passing a hot scalpel over these parts and a portion of the stomach contents was drawn out by means of a fine pipette or platinum loop introduced through the mouth opening. Cultures from the intestines were made in the following manner: After opening the shell, the oyster was removed from the shell and dried between filter papers. A hot spatula was then passed upon the surface of the mollusk directly over that portion of the intestine which it was desired to reach, and the tube was then opened with a sterile scalpel. Through this opening a portion of the contents was drawn out by means of a pipette or platinum loop. Portions of the visceral mass were obtained by cutting out cubes of flesh from that portion of the body after sterilizing the surface with a hot scalpel.

The samples thus obtained were subjected to the same tests that were used in the water analysis—the dextrose fermentation, litmus lactose agar, and carbol broth. In these tests a nutrient gelatin medium containing 0.05 per cent carbolic acid was also employed.

Results.—The first specimens examined were oysters from Fields Point. They were collected at low tide in about 2 feet of water on the long flats that make out from the southern shore of the point. Though live material was scarce near shore, large numbers of dead shells were everywhere scattered over the flats at a little distance from land, and when the oysters obtained from this locality were opened they were found to be lean and unhealthy. The bodies were dark brown, almost black in color, while the mantle folds were, in 8 of the 10 examined, a bright green color.

There are also some clam flats and thatch grass, in which mussels were found, on the south shore of the point, within half a mile of the sewer outlet. A good set of clams was found in this beach in 1900, and at the time these specimens were secured several diggers were rapidly filling baskets for the market. These clams were large and fat, though the shells were black, and the "rims" and "snouts" were dark yellow in color. There were, however, large numbers of dead clams strewn everywhere over the beach, and a drift of white shells marked the high-tide limit. When these clams were dug samples of the sand

were also taken 6 inches below the surface. A few mussels also were obtained from the thatch near by. Perhaps it may be repeated that the beach on the southern exposure of Fields Point, for a distance of more than a quarter of a mile from the sewer outlet, is covered with foul-smelling grayish slime. The water that comes up on the flats with the rising tide is charged with sewage matters, and leaves a deposit of slime on the rocks and shore below the low-water mark and a trail of filth and organic refuse along the high-water line.

The results of the analysis of these shellfish are given in the following table:

TABLE VIII.—*Analysis of oysters, clams, and mussels, collected at Fields Point.*

Specimens, and date of collection.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, March 18, 1901.				
1. Juice	+	+	+	+
2. Juice	+	+	+	+
3. Juice	+	+	+	....
4. Juice	+	+	+	+
5. Juice	+	+	+	+
6. Juice	+	+	+	....
1. Intestine	+	[a]	+	+
2. Intestine	+	+	−	+
3. Intestine	+	+	+	....
4. Intestine	+	+	+	+
5. Intestine	+	[a]	+	....
6. Intestine	+	[a]	+	....
Mud on oyster shells	+	[a]	+	....
Mud on oyster shells	+	[a]	−	+
Oysters, March 25, 1901.				
1. Juice	+	[a]	+	....
1. Intestine	+	[a]	+	+
2. Intestine	+	[a]	+	+
3. Intestine	+	[a]	+	....
4. Intestine	+	+	+	....
1. Stomach	[b]	....	....	....
2. Stomach	+	+	+	....
3. Stomach	+	[a]	+	....
Rectum	+	+	+	....
Clams, March 18.				
1. Juice	+	[a]	+	....
2. Juice	+	[a]	+	....
1. Pieces of visceral mass	+	+	+	....
2. Pieces of visceral mass	+	+	+	+
3. Pieces of visceral mass	+	+	+	+
4. Pieces of visceral mass	+	+	+	+
Sand	+	[a]	+	....
Sand	+	+	+	....
Sand	+	+	+	....
Clams, March 21.				
1. Juice	+	+	+	....
1. Pieces of visceral mass	+	[a]	+	....
2. Pieces of visceral mass	+	[a]	+	....
3. Pieces of visceral mass	+	[a]	+	....
4. Pieces of visceral mass	+	+	+	....
Mussels, March 21.				
1. Juice	+	+	+	....
2. Juice	−	+	−	....
1. Pieces of visceral mass	+	[a]	+	....
2. Pieces of visceral mass	+	[a]	+	....
3. Pieces of visceral mass	+	[a]	+	....
4. Pieces of visceral mass	+	[a]	+	....

[a] Not made. [b] No growth.

Table VIII shows clearly that shellfish living in close proximity to this large sewer outlet are almost without exception infected with

Bacillus coli and other sewage bacteria. In the above recorded 10 oysters, *B. coli* was found without exception in tests made from the juice. In only one instance was it absent from the intestines, and when growth developed in tubes inoculated from the stomach content this organism was also recognized. The analysis of clams and mussels gave similar results. *B. coli* was repeatedly found in the cultures. In addition, *B. cloacæ*, *Bact. lactis-aerogenes* and *B. sporogenes* were isolated from plates inoculated with material from both oysters and clams obtained from the neighborhood of Fields Point.

The next specimens tested for *B. coli* were some clams and mussels from Pawtuxet Neck, 2 miles below Fields Point, taken on the beach which forms the northern shore of the neck where it juts out from the main shore line. The shore at this point was obviously contaminated, and only a few small clams were found alive, while the beach was strewn with heaps of the dead shells. Mussels also grew sparingly in the thatch near by. A fresh set of young oysters was observed on the piles of the Rhode Island Yacht Club boathouse, but they were too small to be of use in this work. The results of the analysis of the few clams and mussels obtained from Pawtuxet Neck are found in Table IX.

TABLE IX.—*Analysis of clams and mussels from Pawtuxet Neck.*

Specimens and date of collection.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Clams, May 7.				
1. Juice	+	(a)	+	....
2. Juice	+	(a)	+	....
3. Juice	+	(a)	−	....
1. Pieces of visceral mass	+	(a)	+	....
2. Pieces of visceral mass	+	(a)	+	....
3. Pieces of visceral mass	+	(a)	−	....
4. Pieces of visceral mass	+	(a)	−	....
5. Pieces of visceral mass	+	+	+	....
6. Pieces of visceral mass	+	+	−	....
Mussels, May 7.				
1. Juice	+	(a)	+	....
2. Juice	+	(a)	+	....
3. Juice	+	(a)	+	....
1. Pieces of visceral mass	+	+	+	....
2. Pieces of visceral mass	+	+	+	....
3. Pieces of visceral mass	+	+	+	....
4. Pieces of visceral mass	+	−	−	....

[a] Not made.

Practically every specimen collected on the Pawtuxet shore contained *B. coli*. No other species of fecal bacteria were isolated.

The Sabins Point oyster ground lies directly across the river from Pawtuxet, close to the eastern shore. In April and May, 1901, two batches of oysters were dredged from this bed in from 6 to 12 feet of water on the east side of the ship channel, and inoculations were made from the juice, stomach, and intestines of these specimens. The results of the tests are given below:

Fourteen of the twenty oysters taken from this bed, 2 miles below

Fields Point, contained *B. coli*, either in the juice or in the intestines. In one case the stomach was found sterile; in another, the stomach tests did not give the reactions for this organism; in a third, however, *B. coli* was isolated from tubes inoculated with material from the stomach. The bacillus was not found in the rectum of the one oyster examined in this respect. *Bact. lactis aerogenes* and *B. sporogenes* were observed in the tests from the juice and intestines of a number of the specimens.

The majority of the oysters, clams, and mussels taken from the Providence River at a distance of about 2 miles from the sewer outlet contain evidences of sewage pollution. As might be expected, however, fewer samples from the eastern side of the river than from the western were found infected. About 70 per cent of the oysters from the Sabins Point bed contained *B. coli*, while practically all of the clams and mussels from Pawtuxet were contaminated.

The next batch of oysters examined was obtained from the Bullock Neck ground off the eastern shore of the river, not far from the Bullock Point light, about 4 miles below Fields Point. These oysters were dredged in from 18 to 20 feet of water and were obtained fresh from the boats working over the beds. Three lots were taken from this locality; in all 15 oysters were examined. Table XI is a record of this analysis.

TABLE X.—*Analysis of oysters from Sabins Point beds.*

Specimens and date of collection.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, April 19, 12 feet of water.				
1. Juice	+	+	+	....
2. Juice	+	+	+	+
3. Juice	+	+	+	....
1. Intestine	+	+	+	....
2. Intestine	+	+	+	+
3. Intestine	−	+	−	....
4. Intestine	−	−	−	....
5. Intestine	−	+	−	....
6. Intestine	+	−	−	....
7. Intestine	+	+	+	....
8. Intestine	+	+	+	....
9. Intestine	+	+	+	....
10. Intestine	+	+	+	....
Oysters, May 20.				
1. Juice	+	(a)	+	....
2. Juice	+	(a)	+	....
3. Juice	+	(a)	+	+
4. Juice	+	(a)	+	....
1. Intestine	+	(a)	+	....
2. Intestine	+	(a)	+	....
3. Intestine	+	(a)	+	....
4. Intestine	+	+	+	....
5. Intestine	+	+	+	+
6. Intestine	−	+	−	....
7. Intestine	+	+	+	....
8. Intestine	−	−	−	....
9. Intestine	+	+	+	....
10. Intestine	+	+	+	....
1. Stomach	No growth.	....	....	....
2. Stomach	−	−	−	....
3. Stomach	+	+	+	....
Rectum	−	−	−	....

a Not made.

TABLE XI.—*Analysis of oysters from the Bullock Neck oyster beds.*

Specimens and date of collection.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, October 17, 1901.				
1. Juice	+	(a)	−	....
2. Juice	+	(a)	+	....
3. Juice	+	(a)	−	....
4. Juice	+	(a)	+	....
5. Juice	+	(a)	+	....
1. Intestine	+	(a)	−	....
2. Intestine	+	(a)	−	....
3. Intestine	−	(a)	−	....
4. Intestine	+	(a)	+	....
5. Intestine	+	(a)	−	....
Oysters, October 23.				
1. Juice	+	+	+	....
2. Juice	+	+	+	....
3. Juice	+	+	+	....
4. Juice	+	+	−	....
5. Juice	−	+	−	....
1. Intestine	+	+	−	....
2. Intestine	−	+	−	....
3. Intestine	+	+	+	....
4. Intestine	−	+	−	....
5. Intestine	+	+	−	....
Oysters, October 30.				
1. Juice	+	+	−	....
2. Juice	+	−	−	....
3. Juice	+	+	−	....
4. Juice	+	+	+	....
5. Juice	+	+	−	....
1. Intestine	+	+	+	....
2. Intestine	−	−	−	....
3. Intestine	−	+	−	....
4. Intestine	+	−	−	....
5. Intestine	+	−	−	....

a Not made.

B. coli was found in a very large number of oysters, clams, and mussels taken above Bullock Neck, while only 8 of the 15 specimens taken from this (Bullock Point) bed were found to be infected. The organism was occasionally found in the juice of oysters whose intestines did not contain it. While nearly all the shellfish from Fields Point and Pawtuxet contained *B. coli* and other fecal bacteria, and while 70 per cent of the oysters from the Sabins Point bed were found to be infected, about 53 per cent of the specimens taken from the Bullock Point bed, 4 miles below the main sewer outlet, contained the colon bacillus.

The next lot of oysters was obtained from the bed off the northern shore of Conimicut Point, which, as already stated, is 5½ miles below Fields Point and is planted in from 6 to 18 feet of water. Twenty-five oysters from this bed were opened and examined, with the following results (p. 224), cultures being taken from the intestines only of these specimens.

TABLE XII.—*Analysis of oysters from Conimicut Point.*

Specimens and date of collection.	Dextrose.	B. coli.	Other fecal bacteria.
Oysters, May 29, 1901.			
1. Intestine	+	+	+
2. Intestine	+	+	....
3. Intestine	—	—	....
4. Intestine	+	—	....
5. Intestine	—	—	....
6. Intestine	—	—	....
7. Intestine	—	—	....
8. Intestine	—	—	....
9. Intestine	—	—	....
10. Intestine	—	—	....
11. Intestine	+	+	....
12. Intestine	+	+	....
13. Intestine	+	—	....
14. Intestine	—	—	....
15. Intestine	+	—	....
Oysters, October 1, 1901.			
1. Intestine	—	—	....
2. Intestine	—	—	....
3. Intestine	—	—	....
4. Intestine	+	—	....
5. Intestine	+	+	....
6. Intestine	—	—	....
7. Intestine	+	+	....
8. Intestine	—	—	....
9. Intestine	—	—	....
10. Intestine	+	+	+

Eight of the 25 oysters from the Conimicut Point bed or 32 per cent, were infected with *B. coli*, and *Bact. lactis-aerogenes* was found in three of the specimens.

Returning to the eastern shore, a number of oysters were collected on the layings directly south of Nayatt Point, at about the same distance from the Fields Point sewer as those taken from the Conimicut side. The channel keeps well over to the eastern shore at this point in the river, and consequently the Nayatt beds are planted in about 20 feet of water and in the course of a much stronger tide than that which sweeps the Conimicut shore. Fewer oysters from this bed were found to be infected with sewage bacteria than from any of the beds previously examined. The accompanying table gives the results of these analyses:

TABLE XIII.—*Analysis of oysters from the Nayatt beds.*

Specimens and date of collection.	Dextrose, fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, May 30.				
1. Intestine	+	(a)	+	....
2. Intestine	—	(a)	—	....
3. Intestine	—	(a)	—	....
4. Intestine	—	(a)	—	....
5. Intestine	—	(a)	—	....
1. Juice	+	(a)	+	....
2. Juice	—	(a)	—	....
3. Juice	+	(a)	—	....

a Not made.

TABLE XIII.—*Analysis of oysters from the Nayatt beds*—Continued.

Specimens and date of collection.	Dextrose, fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, October 14.				
1. Intestine	+	+	+	....
2. Intestine	+	+	+	....
3. Intestine	−	−	−	....
4. Intestine	−	+	−	....
5. Intestine	−	−	−	....
6. Intestine	−	+	−	....
1. Rectum	−	−	−	....
2. Rectum	+	−	−	....
Oysters, October 22.				
1. Intestine	+	+	+	....
2. Intestine	−	−	−	....
3. Intestine	−	+	−	....
4. Intestine	−	−	−	....
5. Intestine	+	+	+	....
Oysters, November 5.				
1. Intestine	−	+	−	....
2. Intestine	−	−	−	....
3. Intestine	+	−	−	....
4. Intestine	−	+	−	....
5. Intestine	−	+	−	....
1. Juice	+	−	−	....
2. Juice	−	+	−	....
3. Juice	+	+	−	....
4. Juice	−	+	−	....

These results show a still further decrease in the infection. About 23 per cent of the specimens examined contained *B. coli.* It is possible, however, to demonstrate the presence of sewage bacteria in oysters living from 5 to 6 miles distant from the sewer outfall.

Passing now from the western side of the river below Conimicut Point, a number of samples—four batches, making 32 oysters in all—were taken from the Rocky Point oyster ground. Two batches were obtained from the beds off Bayside, and two from the beds off Warwick Neck, below Rocky Point. No one of the tubes inoculated with material from the intestines of these specimens gave reactions for *B. coli.* This organism was, however, found in the juice of a single oyster from the Bayside beds. The stomachs of 10 of the specimens were examined, but *B. coli* was not found in any of these analyses. These lots were taken from the river at a distance of 6 and 7½ miles, respectively, from the Fields Point sewer outfall.

Oysters from the Warren River grounds, on the other hand, were more or less contaminated by sewage. Table XIV gives the results of the analyses of 8 oysters dredged off the mouth of this river.

TABLE XIV.—*Analysis of oysters from Warren River.*

Specimens and date of collection.	Dextrose, fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, October, 1902.				
1. Juice	+	+	+	....
3. Juice	+	+	+	....
4. Juice	+	+	+	....
5. Juice	+	+	+	....
6. Juice	+	+	+	....
1. Intestine	+	+	+	....
2. Intestine	−	−	−	....
3. Intestine	+	+	+	....
4. Intestine	+	+	+	....
5. Intestine	+	+	+	....
6. Intestine	+	+	+	....
7. Intestine	+	+	−	....
8. Intestine	−	−	−	....
5. Stomach	(*a*)	....	....	....
6. Stomach	+	−	−	....
8. Stomach	−	−	−	....

a No growth.

The intestines of 5 of the 8 oysters examined contained *B. coli*, which was also found in the juice of these 5 specimens. The stomachs of 3 were tested for colon forms, and two tests gave negative reactions; the tube inoculated from the third oyster remained sterile.

The next lot of oysters examined was obtained from the beds situated under the lee of Pine Hill Point, Prudence Island. These beds are 12 miles from Fields Point, out of the direct course of the river, which is continuous with the eastern passage of the bay, and are farther removed from any source of sewage pollution than are any other oyster beds in the river or bay. The intestines of 10 specimens from this bed did not contain colon forms. The juice and stomachs of 5 were found to be free from any sewage bacteria.

A more extended study was made of the oysters from Wickford Harbor, which, as has already been stated, is well down the western passage of the bay and far removed from sewage pollution. The water over these oyster beds has been analyzed a number of times, and *B. coli* has never been found. About 30 oysters were obtained from this locality in March and April, 1902, and examined by the fermentation-tube methods already described. No bacteria resembling organisms of the colon group were found in the intestines, though organisms fermenting dextrose broth were occasionally observed. No growth developed in 70 per cent of the tubes inoculated with the stomach content, and when growth occurred it was not due to the colon bacillus. The juice of 8 of these oysters did not contain *B. coli*.

In addition to the above series of fermentation tests for *B. coli* on Wickford oysters, a second series, with a gelatin medium containing 0.05 per cent carbolic acid, was carried out on another lot from this same locality. The intestinal content only of the oysters was subjected to analysis; no tests were made for the juice or stomach content.

After inoculation the plates were allowed to develop three or four days at room temperature and then examined for growths of *B. coli.* The oysters used were received in the laboratory twice a week during October, November, and December of 1902, and the specimens were opened within eight hours after they had been taken from the water. The intestines of 200 oysters were examined in this manner. After a week's growth all but 3 of the 200 plates remained sterile. The colonies developing on these 3 were those of a large spore-forming aerobic bacillus, which resembled *B. vulgatus* very closely in cultural features and bore no resemblance to *B. coli.* Some time after these experiments were carried on a series of control plates (nutrient gelatin containing 0.05 per cent carbolic acid) were inoculated with a known culture of *B. coli*, and it was found that this organism grew readily in the carbol gelatin.

The two remaining beds visited in the course of this work are situated, one in the entrance to Mount Hope Bay off Bristol Ferry, and the other in the Kickemuit River. One examination was made in October, 1902, of the oysters from the bed at the entrance to Mount Hope Bay. The results of this work are found in Table XV:

Table XV.—*Analysis of oysters from Bristol Ferry.*

Specimens and date of collection.	Dextrose fermented.	Red colonies on litmus lactose agar.	B. coli.	Other fecal bacteria.
Oysters, October 30, 1902.				
1. Intestine	+	+	+	....
2. Intestine	+	+	−	....
3. Intestine	−	+	−	....
4. Intestine	−	−	−	....
5. Intestine	−	−	−	....
6. Intestine	+	+	−	....
7. Intestine	−	+	−	....
8. Intestine	+	−	−	....
9. Intestine	−	+	−	....
10. Intestine	−	−	−	....
1. Juice	+	+	+	....
2. Juice	+	+	+	....
3. Juice	−	+	−	....
4. Juice	−	−	−	....
5. Juice	−	−	−	....

B. coli was found in the juice of but two specimens and in the intestines of a single one. The Kickemuit River beds are 4½ and the Bristol Ferry beds 7 miles from Fall River. Neither ground is contaminated by sewage from that city, and the slight pollution found at Bristol Ferry is due to local causes. Four batches of oysters were obtained from Kickemuit River. In all, 20 oysters were examined, and it was found that *B. coli* was not present in the intestines or juice of these specimens.

The foregoing analyses demonstrate the following facts:

Oysters, clams, and mussels taken from the Providence River or its shores within half a mile of the Fields Point sewer outlet contain *B. coli* and other fecal bacteria within their shells.

Practically all of the clams and mussels analyzed as representing the condition of shellfish on the Pawtuxet shore, 2 miles below the city sewer, were infected with colon bacilli; but 70 per cent, however, of the oysters taken on the Sabins Point oyster ground, which lies directly across the river from Pawtuxet Neck, were thus infected.

Fifty-three per cent of the oysters collected from the Bullock Neck layings, about 4 miles south of Fields Point, contained *B. coli.*

Thirty-two per cent of the oysters obtained from the Conimicut Point ground, 1½ miles below the locality where the oysters from the Bullock Neck layings were dredged, contained colon bacilli.

Twenty-three per cent of the specimens dredged on the Nayatt Point oyster beds were infected.

On the other hand, oysters from the Rocky Point ground, 6 to 8 miles below the chief source of sewage contamination of the river, are practically free from pollution. *B. coli* was isolated from but one specimen of a lot of 32 oysters which were obtained from these grounds.

A sharp rise in the percentage of oysters infected with sewage forms was noticed when specimens from the Warren River were analyzed. Five out of a total of 8 oysters examined were infected with *B. coli.*

Oysters from Prudence Island and Wickford Harbor do not contain *B. coli* or other sewage bacteria.

Oysters from the Kickemuit River were not infected with these organisms. Only a small percentage of the specimens taken from the layings in the entrance of Mount Hope Bay contain any trace of sewage bacteria.

COMPARISON OF RESULTS OF WATER ANALYSIS AND SHELLFISH ANALYSIS.

If we consider the presence of *B. coli* in waters and food stuffs an indication of sewage contamination, we may trace the distribution of sewage in the Providence River and Narragansett Bay as follows: Starting in the neighborhood of Fields Point and proceeding gradually down the river to the bay below, we find that all water samples taken within a radius of one-half to three-quarters of a mile from the Providence city sewer outlet contain *B. coli*, and often other species of bacteria commonly found in sewage. *B. coli* was abundant, not only in the water about Fields Point, but was readily isolated from samples of sand taken from the beaches near by; also oysters collected from these highly polluted waters, and clams and mussels from the shores within half a mile from the sewer outlet, without exception, contained *B. coli*, and in many cases other sewage bacteria, within their shells.

Nearly all the water samples collected at Pawtuxet Neck, about 2 miles below Fields Point, were found to contain *B. coli;* also most of the shellfish (clams and mussels) obtained from this section of the

river were infected. Seventy-four per cent of the water samples taken over the Sabins Point oyster ground, directly across the river from Pawtuxet, gave positive tests for *B. coli.* Seventy per cent of the oysters from this ground contained this organism within their shells.

Fifty-nine per cent of the water samples taken over the Bullock Neck oyster beds, 2 miles below Sabins Point, contained *B. coli.* This organism was isolated from 53 per cent of the oysters obtained from this locality.

Fifty per cent of the water samples collected on the Conimicut Point oyster beds, but only 32 per cent of the oysters from this source contained *B. coli.*

Off Nayatt Point, 5½ miles south of Fields Point, the water is much freer from sewage pollution. Thirty-one per cent of the water samples and only 23 per cent of the oysters taken from this part of the river contained colon bacilli.

The Warren River, however, is a polluted stream, *B. coli* being frequently found in a series of samples taken at intervals from the mouth of this river to the town of Warren; and also in a sample taken in the Providence River in the flow of the tide from the Warren River, though this pollution is soon swallowed up in the larger volume of the Providence River, so that no trace of *B. coli* can be found 2 miles distant from the entrance of the Warren River. The bacillus was found in over 60 per cent of the oysters taken from the Warren River beds.

On the western side of the river, 6 to 8 miles below the sewer outlet, *B. coli* is found only occasionally and then on a falling tide. It was present in only one oyster from this section of the river.

From the above data it may be noted that the zone of sewage pollution of the Providence River reaches southward from the Fields Point sewer outlet for a distance of about 6 miles.

In Narragansett Bay proper a different set of conditions exists. The western passage is free from sewage pollution, and neither the water nor oysters at Prudence Island or Wickford are infected with the colon or other sewage bacteria.

The Fall River sewer is, of course, the principal source of contamination of the waters of Mount Hope Bay, but it is at least 4 miles away from the nearest oyster bed, and the water and oysters from the Kickemuit River are not found to be infected with any sewage bacteria. In the sample from the Narrows, the entrance to Mount Hope Bay, *B. coli* was found in a single instance. Two oysters from the beds situated off the shore of Bristol Ferry were infected.

The above results are condensed in the following table:

TABLE XVI.—*Correlation of the results of water and shellfish analyses.*

Locality.	Distance from the Providence sewer outlet.	*B. coli* in water.	*B. coli* in oysters.	*B. coli* in clams.	*B. coli* in mussels.
	Miles.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Providence River:					
Fields Point	$\frac{1}{4}$–$\frac{1}{2}$	100	100	100	100
Pawtuxet	2	100	....	$66\frac{2}{3}$	75
Sabins Point oyster bed	2	74	70	....	....
Bullock Point bed	4	59	53	....	....
Conimicut Point	$5\frac{1}{4}$	50	32	....	....
Nayatt Point	$5\frac{1}{4}$	31	23	....	....
(Warren River)	....	100	$67\frac{1}{2}$	....	....
Bayside	$6\frac{1}{2}$	$6\frac{2}{3}$	$3\frac{1}{3}$	....	....
Warwick Neck	$7\frac{1}{2}$	0	0	....	....
Narragansett Bay:					
Prudence Island	12	0	0	....	....
Wickford	19	0	0	0	0
Mount Hope Bay (Fall River sewer):					
Kickemuit River	4	0	0	....	....
Bristol Ferry	7	20	20	....	....

THE BACTERIOLOGY OF OYSTERS FROM UNPOLLUTED SOURCES.

Before commencing the systematic examination of shellfish from different sections of the bay for sewage contamination an attempt was made to gain some knowledge of the bacterial content of oysters from sources known to be free from all sewage contamination. Inoculations were made from the juice, intestines, and stomachs of these specimens, nutrient gelatin, reaction 1.5+, being used in this work. Plates were allowed to develop for two or three days at room temperature, and the colonies were fished out and studied in pure culture. As many as possible of these cultures were identified, and a few which did not appear to be identical with species already described, yet were frequently found in the oysters examined, are described in this paper. For convenience I have prepared the accompanying chart, similar to one proposed by the American Public Health Association for use in the description of water bacteria, and have relied principally upon the list of reactions given in this table for the description of these forms. Gelatin plate cultures were also made from water samples collected at the same places from which the oysters were obtained, in order to make a comparison between the bacterial content of the oyster and the water in which it lives.

For this purpose oysters and water samples were collected at Kickemuit River, Wickford Harbor, and the shores of Greenwich Bay. Twenty young native oysters growing on a mud flat left uncovered at low water were obtained from the last-named locality. Plates were inoculated with scrapings from the stomachs of 5 of these specimens and with samples of juice from 20.

Of the 5 plates inoculated with material taken from the stomach, 3 remained sterile and 2 developed but a few scattered colonies, which,

with a single exception, proved to be growths of micrococci. One of these, a yellowish growth, was a large sarcina, forming regular packets of cells, and coinciding closely with the description given for *Sarcina subflava*. A flesh-colored growth proved to be *Micrococcus carneus*. *M. concentricus* was also observed in these plates. The single bacillus type found was *Ps. fluorescens*.

Plates inoculated with the juice of these oysters, on the other hand, exhibited a considerable difference in appearance from those already described. An abundant growth developed in this series of plates, and in some cases the gelatin was entirely liquefied by the large numbers of bacteria present, so that only very small quantities of this juice could be added to the culture tubes. The predominant forms found in these plates were bacilli. Only three species of micrococci were observed. *M. luteus* and *M. carneus* were found in 5 out of 20 plates. A large micrococcus, forming a thick white layer on agar and agreeing closely with *M. simplex*, was found in two plates. Ten species of bacillus tpye were distinguished, perhaps the most frequently observed form being *Ps. fluorescens*, which was found in 80 per cent of the samples examined. A nonliquefying fluorescent bacillus, probably *B. rugosus*, was found in 9 plates. For the rest, *B. limosus* was found in 11 plates out of the 20 examined; a large granular bacterium which grew into long anthrax-like chains and formed small oval spores, *Bact. maritimum*, in 7; *B. vulgatus* in 5; *B. sublanatus* in 4; *B. circulans* in 7; *B. cuticularis* in 3, and *B. cyanogens* in 2 plates of the 20 examined. Most of the organisms liquefy gelatin rapidly, so that the plates are pitted with shallow crater-like depressions in two days. The same organisms were also found in a set of gelatin plates made from water samples obtained from this locality at high tide.

The Kickemuit River oyster bed furnished the next supply of oysters used in this analysis, full-grown specimens dredged in about 16 feet of water; 30 oysters from these layings were obtained and examined in the fall of 1900. The stomach content of 20 of these, samples of the juice of 15, and portions of the intestinal content of 10 were inoculated into the usual gelatin medium. The plates inoculated from the juice of these oysters did not develop growth different in many respects from that obtained from the Greenwich Bay oysters. Liquefying organisms were most numerous, often destroying the plates in a few days. Four species of micrococci were observed in this series: *M. auriantiaca*, *M. concentricus*, *M. luteus*, and *Sar. lutea*.

M. auriantiaca was found in 20 per cent of the samples examined; *M. luteus*, *M. concentricus*, and *Sar. lutea* a less number of times. The bacillus forms observed most frequently were those common in water; *B. subtilis*, *B. limosus*, and *Ps. fluorescens* were most plentiful. *Bact. maritimum* and *B. vulgatus* were also found in these samples.

Sixty per cent of the plates inoculated with material from the stomachs of Kickemuit River oysters remained sterile. Two of the 8 plates that showed growth in three days contained large numbers of colonies of *Ps. fluorescens*, *M. luteus*, *M. flavus*, *M. carneus*, and a species of sarcina (not described in this paper). A nonliquefying fluorescent bacillus was also observed in a number of cases, forming regular glistening colonies that look like small drops of water on the surface of the gelatin, which takes on a pale green fluorescence. This organism is described on the chart as bacillus No. 11.

The 10 plates inoculated from the intestinal content of these specimens developed abundant growth in two days. Liquefying bacilli were present in great numbers. Again *Ps. fluorescens* was met with in a large percentage of plates examined; also a small motile liquefying organism, bacillus No. 6, was found in 6 of the 10 plates. Colonies liquefy slowly and form bluish-white depressions in the gelatin, some reaching a diameter of 5 mm. in four days. Microscopically they have a granular center around which is a clear hyaline area that usually has a distinctly wavy margin. By transmitted light they resemble a bluish star with a dark white center surrounded by a thin, irregular bluish growth. Agar, gelatin, and broth cultures of this organism assume a characteristic brown color after about two or three weeks' growth at room temperature. Colonies of *B. mesentericus* (variety *fuscus*), *B. subtilis*, *Bact. maritimum*, and of the nonliquefying fluorescent bacillus No. 11, already referred to, were found in these plates. *M. flavus* and *M. auriantiaca* were met with on several occasions.

A more extended study of the flora of the oysters' intestines was made on several lots of specimens obtained from Wickford Harbor in the fall of 1902. In this series of experiments material from the intestinal content of 100 oysters was inoculated into the usual gelatin medium. This analysis was begun October 14, and from that date specimens were obtained twice a week for over two months. Arrangements were made with the parties controlling the Wickford oyster beds, by which oysters caught Tuesday and Thursday mornings were shipped to Providence and received in the laboratory the same day they were taken from the water. They were then immediately opened and cultures taken from the intestines.

Plates made from Wickford oysters as a rule developed a large number of liquefying colonies, and though the organisms most frequently observed were rod forms, colonies of micrococci were occasionally met with. *M. flavus* was found in 5 per cent of the plates examined; also cultures of *M. luteus* and *M. auriantiaca* were taken from colonies developing on 3 of these plates. Another coccus form more frequently met with in this examination is referred to on the

chart as micrococcus No. 1. It occurs in pairs and short chains of 4 or 6 elements that vary considerably in size according to the medium on which they are cultivated. Grown on gelatin the cocci are considerably over 1 micron in diameter; in bouillon they are somewhat less than 1 micron. This organism was observed in 15 per cent of the oysters examined.

There is a greater variety among the rod forms isolated from the plates. An organism closely resembling *Ps. fluorescens* was found in 89 of the 100 samples examined. Another fluorescent bacillus occurring in 60 per cent of these plates is referred to on the chart as No. 11. This is a nonliquefying, strongly fluorescent organism that differs from No. 5 only in certain of its cultural features. These three fluorescent bacilli were found repeatedly in the plates made from the Wickford oysters. Some plates appeared to contain almost pure cultures of *Ps. fluorescens* and *B. rugosus*. Bacillus No. 2 was found in the intestinal content of 15 of these oysters. It is a small, actively motile bacillus that grows well at room temperature and at 37° C. The presence of a very dilute solution of carbolic acid in the culture medium (one drop of a 5 per cent solution to 10 c.c. of medium) entirely inhibits the growth of this organism. Four unidentified species (No. 6) already described among the bacterial flora of the Kickemuit River oysters (No. 7, No. 8, and No. 10) were found in the plates inoculated from the intestinal content of Wickford oysters. Bacillus No. 6 was found in 30 plates, No. 7 in 20 plates, and the other two in a much less number. *B. subtilis*, *B. vulgatus*, and *B. mesentericus fuscus* were isolated from the intestines of these oysters.

In a word, the bacteria living in oysters taken fresh from pure water are common water forms. An analysis of the juice of oysters is practically the analysis of the water in which the oysters live. The stomachs of 60 per cent of the specimens examined appeared to be sterile—at least no growth developed in plates inoculated with material from this organ. Most of the bacteria found in the stomachs proved to be micrococci. On the other hand an abundant growth appeared on plates inoculated with material taken from the intestines of oysters collected in different sections of the bay. Liquefying organisms seemed to predominate, and large numbers of fluorescent bacilli were repeatedly observed, but no bacteria in any way resembling sewage forms were found. For a complete list of the bacteria isolated from these oysters the reader is referred to the accompanying chart.

Bacteria found in normal oysters.

No.	Source.	Name.	Morphology. Bacillus.	Morphology. Micrococcus.	Morphology. Diameter more than 1 μ.	Morphology. United in chains.	Morphology. Motile.	Morphology. Forms spores.	Morphology. Stains by Gram's method.	Cultural features. Broth. Turbid.	Cultural features. Broth. Scum.	Cultural features. Broth. Sediment.	Cultural features. Agar. Dull.	Cultural features. Agar. Wrinkled.	Cultural features. Characteristic growth on gelatin plate.	Cultural features. Gelatin stab. Deep funnel.	Cultural features. Gelatin stab. Surface growth.	Cultural features. Gelatin stab. Needle growth.	Cultural features. Potato. Visible.	Cultural features. Potato. Luxuriant.	Cultural features. Grows in closed arm of fermentation tube.	Biochemical features. Grows at 37.5° C.	Biochemical features. Facultative aerobic.	Biochemical features. Liquefaction. Gelatin.	Biochemical features. Liquefaction. Casein.	Biochemical features. Liquefaction. Blood serum.	Biochemical features. Gas production. Dextrose broth.	Biochemical features. Gas production. Lactose broth.	Biochemical features. Gas production. Saccharose.	Biochemical features. Indol produced.	Biochemical features. Nitrates reduced.	Biochemical features. Milk. Coagulated.	Biochemical features. Milk. Reaction acid.	Biochemical features. Fecal odor.	Biochemical features. Chromogenic.	Biochemical features. Fluorescent.
1	Intestine	M	—	+	+	+	—	—	+	+	—	+	—	—	—	—	+	+	—	—	....	+	+	—	—	—	—	—	—	—	—	—	+	—	—	—
2	do	B	+	—	—	+	+	—	—	+	+	+	—	—	—	+	+	—	+	+	+	+	+	+	+	+	+	—	+	—	—	+	—	—	—	—
3	do	*Ps.* fluorescens	+	—	—	+	+	—	—	+	+	+	—	—	—	—	+	+	+	—	....	+	+	+	+	—	—	—	—	—	—	+	—	—	—	+
4	do	B. vulgatus	+	—	+	+	+	+	+	+	+	..	+	+	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—	—	—	+	—	—	—	—
5	do	B. rugosus	+	—	—	+	+	—	—	+	+	+	—	—	—	—	+	+	+	+	....	—	+	—	—	—	—	—	—	—	—	+	—	—	—	+
6	do	B	+	—	—	—	+	—	—	+	+	+	—	—	—	+	+	+	—	—	+	+	+	+	—	+	—	—	—	—	—	—	+	—	—	—
7	do	B	+	—	+	+	+	+	+	—	+	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+	—	—	—	—	+	+	—	—	—	—
8	do	B	+	—	—	—	+	—	+	+	—	+	—	—	—	—	—	—	+	+	—	—	—	+	+	+	..	..	..	—	—	+	—	—	—	—
9	do	M. flavus	—	+	—	—	—	—	+	+	—	—	—	—	—	—	+	+	+	+	—	+	—	+	—	—	—	—	—	—	—	+	+	—	+	—
10	do	B	+	—	—	+	+	+	+	+	..	..	—	—	—	+	+	+	+	+	+	+	+	+	+	+	+	..	..	—	—	+	—	—	—	—
11	do	B	+	—	—	—	+	—	—	+	+	—	—	—	—	—	—	+	+	+	+	+	+	—	—	—	—	—	—	—	—	+	+	—	—	+
12	Juice	Bact. maritimum	+	—	+	+	—	+	?	—	+	+	+	—	+	—	+	+	+	+	?	+	—	+	?	—	—	—	—	—	..	..	..	—	—	—
13	do	B. limosus	+	—	+	+	+	+	?	+	+	+	—	—	+	+	—	—	—	—	—	—	—	+		+	—	—	—	—	..	..	..	—	—	—
14	do	B. cuticularis	+	—	—	+	+	—	?	+	—	+	—	—	—	—	+	+	+	+	....	+	—	+	..	—	—	—	—	—	..	..	..	—	+	—
15	do	B. circulans	+	—	—	+	+	+	—	+	—	+	—	—	—	—	+	+	+	—	....	+	+	+	+	+	—	—	—	—	+	+	+	—	—	—
16	do	M. luteus	—	+	—	—	—	—	?	—	—	+	—	—	—	—	+	+	+	—	....	—	—	+	..	..	..	..	..	..	..	+	+	—	+	—
17	do	M. carneus	—	+	—	—	—	—	+	—	—	+	—	—	—	—	+	+	+	—	....	+	+	+	—	—	—	—	—	..	..	—	+	—	+	—
18	do	B. sublanatus	+	—	—	—	+	+	—	+	—	—	—	—	—	—	+	+	+	—	....	+	+	+	+	—	—	—	—	—	—	—	—	—	—	—
19	do	B. mesentericus var. fuscus	+	—	—	+	+	+	+	+	+	—	+	+	+	—	+	+	+	+	+	+	+	+	+	+	—	—	—	—	..	—	—	—	—	—
20	do	B. subtilis	+	—	+	+	+	+	+	—	+	—	+	+	+	—	+	+	+	+	—	+	—	+	+	..	—	—	—	—	..	+	—	—	—	—
21	do	B. cyanogens	+	—	—	+	+	—	?	+	+	—	—	—	+	—	+	+	+	—	+	+	+	+	—	—	—	—	..	..	+	—	—	—	—	—
22	do	Sar. lutea	—	+	—	—	—	—	?	—	—	+	—	—	—	+	+	+	+	+	?	+	—	+	—	—	—	—	—	—	—	+	—	+	+	—
23	do	Sar. subflava	—	+	—	—	—	—	?	—	+	+	—	—	—	—	+	—	—	—	....	—	—	+	—	—	—	—	—	—	—	—	+	—	+	—
24	do	M. auriantiaca	—	+	+	—	—	—	+	—	—	—	—	—	—	—	+	+	+	+	....	+	—	—	—	—	—	—	—	—	—	..	..	—	+	—

ANALYSIS OF OYSTERS FROM UNPOLLUTED SOURCES WHICH HAVE BEEN PLACED FOR A TIME IN POLLUTED WATER.

In connection with the above work, it has been interesting to note the effect produced on uncontaminated oysters by allowing them to stand for a time in water highly charged with sewage matters. A number of the oyster companies controlling beds in the lower river and bay have docks and opening houses bordering on the Seekonk River, in the neighborhood of the outlet of one of the small sewers draining the east side of the city of Providence. At times the water in the vicinity of these wharves is filled with all sorts of organic refuse, which passes down the river in a slow stream by the docks. After the oysters have been dredged in the river below, they are brought immediately to the city, and are very often dumped into shallow cars moored close by the oyster houses, where they are allowed to remain in the filthy river water until the openers are in need of new material. They often remain in these cars from one to three days, and thus have plenty of time to take in a good supply of sewage bacteria, even though they were not infected when first brought to the city.

Two batches of oysters that had lain in floats in the Seekonk River for a time were subjected to the same tests used in this work on fresh material. One batch of 5, dredged off Warwick Neck, had lain sixteen hours in one of these floats. As has already been shown, Warwick Neck oysters are not infected with *B. coli* or other sewage bacteria when taken from the beds, but the juice of these 5 specimens gave positive reactions for this organism; it was found in the intestines of 2 or 3 examined. The other batch was brought up from the Kickemuit River, whose beds also are free from sewage pollution and are not infected with the colon bacillus. After these oysters had lain in the car for two days, however, this organism was readily isolated from the juice of all 5, though it was not found in the intestines of any of them. Water samples taken in these cars also contained *B. coli*.

CONCLUSIONS.

The sewage-contaminated area of the Providence River extends downstream from the outlet of the city sewer at Fields Point, a distance of about 5 miles. Below this area is a section about 2 miles wide, extending from one side of the river to the other, in which *B. coli* is occasionally found. The tides and wind have considerable effect upon this section, since evidence of sewage pollution has been found only when samples were collected at very nearly low water.

The waters of Providence River and Narragansett Bay from localities more than 8 miles distant from the principal sewers that discharge into this basin do not contain sewage matters, and do not give positive tests for *B. coli*.

The waters of Mount Hope Bay, at least in the areas occupied by oyster ground, are also free from sewage pollution of any extent.

The Warren River, however, from the town of Warren to its union with the Providence River, must be considered a polluted stream.

Examination of oysters and other shellfish from various portions of the river and bay show that there is a distinct relation between the presence of *B. coli* in the water and in the shellfish living in these waters. When *B. coli* is entirely absent from the water it can not be found in the shellfish, but when the surrounding waters are infected with it it is almost certain to be found in the shellfish. It seems probable, however, that *B. coli* may be present in larger numbers in the water than in oysters, for almost without exception a much larger number of water samples than oysters from a given locality gave positive reactions for sewage bacteria. This fact may be explained as due partly to the influence of the tide currents and partly to the resistance against infection exerted by the oyster itself.

Examination of the shellfish from the lower river and bay demonstrate that the bacteria usually occurring in oysters taken from uncontaminated waters are such forms as are commonly found in water. No organisms of the colon group were isolated from these oysters. Hence, analysis of the juice contained within the shells of oysters, clams, and mussels is practically an analysis of the water in which these molluscs are living. The stomachs of oysters are often found sterile. *B. coli* has been found in the juice of oysters whose intestines were apparently free from infection.

No organism which will grow in the presence of 0.05 per cent of phenol has been found in oysters from an unpolluted source.

The results obtained in these experiments indicate that *B. coli* is not normally found in sea water or in the common edible shellfish, and that the presence of this organism in oysters, clams, mussels, and similar shellfish is an indication of sewage pollution.

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NOTE REGARDING THE PROMOTION OF FISHERY TRADE BETWEEN THE UNITED STATES AND JAPAN

By HUGH M. SMITH
Deputy Fish Commissioner

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Both the United States and Japan are so well supplied with fishery products of all kinds that they are to a very great extent independent in this respect, and it has been believed that the possibility of building up an extensive fishery trade between them is very remote. A personal inquiry into the conditions in Japan, including consultation with the imperial and local fishery officials, confirms the belief that no great development of the general fishery trade can be looked for at this time, but there appear to be opportunities for establishing a mutually beneficial trade in some special products.

The consumption of water products in Japan is enormous. Fish is not only the staple animal food in all parts of the empire, but is the only animal food that enters into the dietary of a very large proportion of the population. In no other country are so many persons engaged in fishing. In a total population of 50 million, 3 million people are engaged in this industry, and fully 10 million men, women, and children are directly dependent on it. A large part of the catch is sold fresh, but considerable quantities of certain species are smoked, dried, salted, canned, or otherwise prepared. No ice is employed in the preservation of fish. This, however, is not serious, as the prosecution of fishing on all parts of the coast, the long coast line, the shape of the islands, and the transportation facilities permit nearly the entire population to receive daily supplies of fresh fish in good condition.

The establishment of a satisfactory export trade with Japan in fishery products depends chiefly (1) on the cheapness of the products, and (2) on their adaptation to the peculiar needs and ideas of the people. It would be futile to send high-priced goods, because the prospective consumers—the masses—can not afford to pay for them, and it would be equally futile to try to force the Japanese to surrender their predilections and tastes and long-established customs, and adopt fishery foods prepared according to western ideas.

Following are some of the products for which a ready market exists or may be created in Japan, and which it would be profitable to export:

Fish guano.—The comparatively small percentage of arable land and the immense agricultural population necessitate the raising of a succession of crops. In no other country is agriculture more intensive, and the continued use of large quantities of fertilizer is required. City refuse, fish, seaweed, straw, grass, brush, and various other things are employed, and a fertilizer made from soy-bean refuse is now imported from China. There exists a very large and constant demand for a cheap, dry fish-guano, such as may be made from waste fish or the refuse of canneries.

Canned fish.—There is as yet no great demand among the Japanese for canned fish, owing to the abundance, availability, and cheapness of fresh fish. As the people become better acquainted with the tinned product, it is probable that the demand will be supplied chiefly by local canneries, which are already putting up an excellent grade of sardines, anchovies, etc. The canned fish prepared in America which seems most likely to be in demand in Japan is salmon. The American Asiatic, in the issue of April 7, 1903, stated: "Every cargo now shows canned salmon moving to the Orient. A year ago such a movement was unknown. Salmon is now selling in the Orient as California canned fruits sold in Europe when they began to be exhibited there." The shipments of canned salmon to Japan, however, are comparatively light, and are destined mostly for consumption among foreign residents there. This product, to meet with ready sale among the natives, must be low priced, retailing at not more than 7½ or 10 cents per 1-pound can. Dog, humpback, and silver salmon could be most advantageously canned for the Japanese trade.

Salted salmon.—It is believed that the fishery product in which there are the best prospects for establishing a profitable trade is salted salmon. The local catch is not sufficient to meet the demand and the supply is decreasing. Small quantities of salted salmon are now imported from the United States, Canada, and Asiatic Russia. Dog salmon and other cheap species of Alaska and the Pacific States would find a ready market if properly prepared; dog salmon is the principal species utilized in Japan. The fish should be split along the abdomen as far as the vent, eviscerated, and lightly salted with the abdomen compressed laterally, not spread, the head being left on. The salting should be so regulated as to leave the fish soft and flexible, not hard and stiff. The best time to ship is November and December, as the greatest demand comes in the latter part of December—dry-salted salmon being very generally given as end-of-the-year and new-year presents. A 10-pound dog salmon now retails for 35 to 50 cents. The value of the imports of salted salmon and trout into Japan in

1902 was $1,005,744, of which only $101,329 came from the United States.

Seaweeds.—Pending the time when the valuable seaweeds now going to waste on the United States coasts will be utilized in various ways, it may be possible to market large quantities of the raw weeds in Japan, where seaweeds are among the most valuable and most widely used of water products. Those species which are convertible into vegetable isinglass (*kanten*) and into the preparation (*funori*) used for stiffening fabrics are in greatest demand and command high prices. The best markets are Tokyo and Osaka.

The products which the Japanese would like to export to the United States are salted bull's-eye mackerel, salted herring, salted and canned sardines, salted cod, smoked bonito, and various preparations of seaweed. In view of the large quantities of salted mackerel, salted herring, and canned sardines now imported into the United States from Europe—the home supply being inadequate—the importation of considerable quantities of these commodities from Japan could be undertaken without detriment to our own fisheries.

STATISTICS OF THE FISHERIES OF THE NEW ENGLAND STATES, 1902

PREPARED IN THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES.

A. B. ALEXANDER,
Assistant in Charge.

STATISTICS OF THE FISHERIES OF THE NEW ENGLAND STATES.

INTRODUCTION.

The information contained in the present report relates to the coast fisheries, not including those of interior waters, of the New England States, and covers the calendar year 1902. The inquiries, which were made by the regular statistical agents of the Bureau, were begun early in July and completed in November, 1903. The statistics obtained have already been published in condensed form in Statistical Bulletin No. 151.

Earlier publications of the Bureau relating to the fisheries of the New England States are the following:

The Fishery Industries of the United States, Section II, Geographical Review of the Fisheries for 1880, Parts I to V.

The Fishery Industries of the United States, Section V, History and Methods of the Fisheries.

Report on the Fisheries of the New England States, by J. W. Collins and Hugh M. Smith. Bulletin U. S. Fish Commission, 1890, pp. 73–176.

Report on the Conditions of the Sea Fisheries of the South Coast of New England in 1871 and 1872, by Spencer F. Baird. Report U. S. Fish Commission, 1871–72, pp. i–xli.

The Sea Fisheries of Eastern North America, by Spencer F. Baird. Report U. S. Fish Commission, 1886, pp. 3–224.

Statistical Review of the Coast Fisheries of the United States, by J. W. Collins. Report U. S. Fish Commission, 1888, pp. 271–378.

The Herring Industry of the Passamaquoddy Region, Maine, by Ansley Hall. Report U. S. Fish Commission, 1896, pp. 443–489.

Notes on the Oyster Fishery of Connecticut, by J. W. Collins. Bulletin U. S. Fish Commission, 1889, pp. 461–497.

The Lobster Fishery of Maine, by John N. Cobb. Bulletin U. S. Fish Commission, 1899, pp. 241–265.

Statistics of the Fisheries of the New England States. Report U. S. Fish Commission, 1900, pp. 311–386.

The number of persons employed in the fisheries of the New England States in 1902 was 39,250, including 10,731 on fishing vessels, 409 on transporting vessels, 12,891 in the shore fisheries, and 15,219 connected with the wholesale fishery trade, sardine canneries, and other shore industries. Maine employed in the various branches of its fisheries 19,832 persons; New Hampshire, 161; Massachusetts, 14,300; Rhode Island, 2,117, and Connecticut, 2,840. Since 1898, the year for which the fisheries of these states were last canvassed, there has been an increase of 3,619 in the number of persons employed. This represents an increase of 2,878 in Maine, 7 in New Hampshire,

430 in Rhode Island, and 367 in Connecticut, but a decrease of 63 in Massachusetts. The largest percentage of increase was 25.48 per cent in Rhode Island.

The amount of capital invested in the fisheries and related industries was $20,008,434. The investment in Maine was $6,939,503; in New Hampshire, $42,002; in Massachusetts, $10,811,594; in Rhode Island, $1,014,280, and in Connecticut, $1,201,055. Compared with the returns for 1898 the investment has increased $371,398, or 1.89 per cent. There was an increase in Maine of $2,926,450.

The investment included 1,479 fishing and transporting vessels, valued at $3,977,066, having a net tonnage of 46,543 tons, and outfits valued at $1,792,990; 11,405 boats in the shore or boat fisheries, valued at $701,729; fishing apparatus used by vessels and boats to the value of $1,323,467; shore and accessory property valued at $7,928,457, and cash capital amounting to $4,284,725. The kinds of fishing apparatus having the largest aggregate value were pound nets, trap nets, and weirs, exclusive of eel weirs, $489,517; lobster pots, $237,398; hand and trawl lines, $229,476; seines, $171,173, and gill nets, $127,064.

The products of the fisheries amounted to 534,075,447 pounds, for which the fishermen received $12,406,284. The yield in Maine was 242,390,371 pounds, valued at $2,918,772; in New Hampshire, 1,593,013 pounds, valued at $50,003; in Massachusetts, 230,645,950 pounds, valued at $6,482,427; in Rhode Island, 21,613,964 pounds, valued at $1,155,701; and in Connecticut, 37,832,149 pounds, valued at $1,799,381. The principal species taken in the fisheries of these states, and their quantity and value, including fresh, salted, and smoked fish, were cod, cusk, haddock, hake, and pollock, 191,664,774 pounds, $3,725,664; halibut, 12,365,705 pounds, $662,838; mackerel, 20,358,982 pounds, $1,136,754; herring, 191,739,467 pounds, $912,220; alewives, 8,437,446 pounds, $89,289; menhaden, 18,469,390 pounds, $56,401; scup, 7,818,530 pounds, $189,429; squeteague, 7,336,052 pounds, $177,622; flatfish and flounders, 4,808,746 pounds, $135,880; sword-fish, 1,689,740 pounds, $118,320; eels, 1,403,758 pounds, $75,171; shad, 1,380,812 pounds, $58,564; smelt, 1,138,718 pounds, $104,429; whiting or silver hake, 2,513,470 pounds, $9,812; squid, 5,496,461 pounds, $28,409; lobsters, 14,756,495 pounds, $1,336,572; hard clams or quahogs, 1,223,200 pounds or 152,900 bushels, $191,357; soft clams, 8,345,470 pounds or 834,547 bushels, $413,990; and oysters, 19,550,643 pounds or 2,792,949 bushels, $2,193,316. There were also a considerable number of species taken in smaller quantities. The products of the whale fisheries, consisting of whale and sperm oil and whalebone, had a value of $382,875.

The products in 1902, as compared with the returns for 1898, have increased 140,617,541 pounds, or 35.73 per cent, in quantity, and $2,723,994, or 28.13 per cent, in value. The value increased in all the states, and the quantity in all except New Hampshire and Rhode Island.

The following tables give the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of the New England States in 1902; also a comparison of the extent of the fisheries in 1898 and 1902:

Table showing the number of persons engaged in the fisheries of the New England States in 1902.

States.	Fishermen.	Shoresmen.	Total.
Maine	9,207	10,625	19,832
New Hampshire	147	14	161
Massachusetts	11,387	2,913	14,300
Rhode Island	1,425	692	2,117
Connecticut	1,865	975	2,840
Total	24,031	15,219	39,250

Table showing the investment in the fisheries of the New England States in 1902.

Items.	Maine.		New Hampshire.		Massachusetts.	
	No.	Value.	No.	Value	No.	Value.
Vessels	585	$722,490	4	$2,150	605	$2,562,351
Tonnage	8,970		55		32,370	
Outfit		227,542		3,075		1,362,708
Boats	6,297	305,181	115	7,270	2,688	213,963
Seines	229	25,672	2	700	253	130,299
Gill nets	3,303	29,586	15	150	9,071	84,311
Pound nets, trap nets, and weirs	780	189,077	24	5,760	170	150,750
Fyke nets	21	182			18	156
Bag nets	221	9,245				
Dip nets	277	926			155	290
Beam trawls					65	3,295
Lines, hand and trawl		42,731		931		182,879
Eel pots and traps	763	674	15	15	994	1,211
Lobster pots	166,437	173,752	2,530	3,535	26,376	36,008
Harpoons		1,467		10		2,853
Spears	98	127			98	157
Eel weirs					28	725
Dredges	96	1,226			1,120	2,699
Tongs, rakes, forks, and hoes	1,905	1,563	18	36	1,541	6,280
Rakes, Irish moss					140	573
Other apparatus		104				212
Shore and accessory property		3,745,483		10,370		3,482,374
Cash capital		1,462,475		8,000		2,587,500
Total		6,939,503		42,002		10,811,594

Items.	Rhode Island.		Connecticut.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels	91	$208,995	194	$481,080	1,479	$3,977,066
Tonnage	1,352		3,796		46,543	
Outfit		53,817		145,848		1,792,990
Boats	1,130	103,841	1,175	71,474	11,405	701,729
Seines	66	5,590	93	8,912	643	171,173
Gill nets	313	6,428	261	6,589	12,963	127,064
Pound nets, trap nets, and weirs	198	125,790	77	18,140	1,249	489,517
Fyke nets	701	4,216	255	3,148	995	7,702
Bag nets					221	9,245
Dip nets	11	16	40	20	483	1,252
Beam trawls					65	3,295
Lines, hand and trawl		1,545		1,390		229,476
Eel pots and traps	3,970	2,888	1,655	1,571	7,397	6,359
Lobster pots	10,534	11,622	6,813	12,481	212,690	237,398
Harpoons		217		375		4,922
Spears	61	43	59	41	316	368
Eel weirs					28	725
Dredges	1,344	7,369	768	9,785	3,328	21,079
Tongs, rakes, forks, and hoes	1,011	2,918	750	2,206	5,225	13,003
Rakes, Irish moss					140	573
Other apparatus						316
Shore and accessory property		359,235		330,995		7,928,457
Cash capital		119,750		107,000		4,284,725
Total		1,014,280		1,201,055		20,008,434

Table showing the quantity and value of products taken in the fisheries of the New England States in 1902.

Species.	Maine.		New Hampshire.		Massachusetts.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore or horse mackerel					75,655	$2,055
Alewives, fresh	1,006,853	$6,955	100,000	$1,000	1,320,350	15,220
Alewives, salted	862,750	4,875	250,000	2,813	1,979,000	24,619
Alewives, smoked	519,850	9,902			114,000	1,140
Blue-fish					194,850	15,742
Bonito					166,470	5,914
Butter-fish	7,780	382			106,050	4,396
Cat-fish and bullheads	479,433	4,002			2,500	50
Cod, fresh	10,902,910	209,781	441,600	11,980	40,658,992	976,219
Cod, salted	6,487,554	166,895			28,862,393	796,723
Cunners	60,753	1,178			140,150	7,734
Cusk, fresh	2,334,147	30,371	20,000	400	2,737,586	42,937
Cusk, salted	158,370	3,137			155,721	2,573
Dog-fish					52,800	200
Eels	221,050	12,683	5,000	200	493,644	25,322
Flat-fish and flounders	568,920	11,951			2,595,667	80,406
Haddock, fresh	6,642,076	120,315	159,200	3,198	38,628,457	793,284
Haddock, salted	361,164	4,677			591,073	8,584
Hake, fresh	16,824,908	123,208	48,850	660	13,880,141	185,128
Hake, salted	1,950,847	21,683			477,813	6,251
Halibut, fresh	209,771	14,195			10,979,806	578,504
Halibut, salted					1,176,128	70,139
Herring, fresh	158,219,500	442,357	100,000	1,000	16,982,903	231,058
Herring, salted	2,905,166	37,532			12,252,298	169,978
Herring, smoked	1,279,600	30,300				
Hickory shad					1,650	25
Mackerel, fresh	1,390,370	79,590	80,000	4,500	9,980,500	495,594
Mackerel, salted	333,000	21,900	15,000	900	7,643,822	485,391
Menhaden, fresh	240,900	1,805			875,000	5,409
Menhaden, salted	5,800	67				
Perch, white	400	30	1,600	160	6,300	630
Perch, yellow	450	30				
Pollock, fresh	4,333,372	36,729	157,800	2,454	10,913,183	102,558
Pollock, salted	1,042,999	12,394			1,262,473	15,210
Salmon	60,768	13,394				
Sand eels					120,000	2,000
Scup					588,900	14,978
Sea bass					96,000	5,679
Shad, fresh	781,899	26,128			21,247	1,137
Shad, salted	67,600	2,831				
Smelt	1,125,268	103,055				
Squeteague					3,770,217	90,252
Striped bass	15,715	2,050	1,500	225	27,909	2,620
Sturgeon	4,700	495			6,535	372
Caviar	455	281				
Suckers	3,550	132				
Sword-fish	642,784	44,613	4,000	400	750,126	57,746
Tautog					213,285	6,437
Tomcod	184,540	2,521			32,000	490
Whiting	91,500	147			2,286,200	7,885
Other fish	28,600	206				
Squid					5,365,076	25,340
Lobsters	12,163,389	1,066,407	128,463	14,863	1,695,688	175,095
Shrimp					6,000	1,500
Quahogs or hard clams					854,544	131,139
Clams (soft), fresh	4,551,360	159,269	30,000	3,000	2,279,410	157,247
Clams (soft), salted	995,200	35,217				
Oysters, market					529,102	120,252
Oysters, seed					194,600	13,430
Scallops	114,656	14,013			396,900	89,982
Cockles and winkles	85,000	1,000			20,000	5,600
Irish moss			50,000	2,250	690,000	31,050
Sounds and tongues	258,216	19,797			11,566	433
Fish roe	16,056	129			16,700	581
Halibut fins					34,400	1,644
Livers	1,839,622	17,849				
Oil, fish	9,300	314			176,403	7,725
Oil, whale					5,136,767	292,875
Whalebone					19,000	90,000
Total	242,390,371	2,918,772	1,593,013	50,003	230,645,950	6,482,427

Table showing the quantity and value of products taken in the fisheries of the New England States in 1902—Continued.

Species.	Rhode Island.		Connecticut.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore or horse mackerel	1,200	$16			76,855	$2,071
Alewives, fresh	451,690	5,267	1,663,153	$15,309	4,545,046	43,841
Alewives, salted	166,800	2,099			3,258,550	34,406
Alewives, smoked					633,850	11,042
Blue-fish	146,335	9,416	348,575	17,833	689,760	42,991
Bonito	125,180	3,360			291,650	9,774
Butter-fish	362,910	10,407	67,218	2,304	543,958	17,489
Cat-fish and bullheads			8,035	303	489,968	4,355
Cod, fresh	690,160	20,652	211,340	7,057	52,905,002	1,225,689
Cod, salted					35,349,947	963,618
Cunners					200,903	8,912
Cusk, fresh					5,091,733	73,708
Cusk, salted					314,691	5,710
Dog-fish					52,800	200
Eels	451,740	22,290	232,324	14,676	1,403,758	75,171
Flat-fish and flounders	1,134,870	27,839	509,289	15,684	4,808,746	135,880
German carp			2,134	164	2,134	164
Haddock, fresh	506,195	11,265	189,150	5,897	46,125,078	936,959
Haddock, salted					952,237	13,261
Hake, fresh					30,753,899	308,996
Hake, salted					2,428,660	27,934
Halibut, fresh					11,189,577	592,699
Halibut, salted					1,176,128	70,139
Herring, fresh					175,302,403	674,410
Herring, salted					15,157,464	207,510
Herring, smoked					1,279,600	30,300
Hickory shad	31,760	700			36,410	725
King-fish	3,430	364	1,500	105	4,930	469
Mackerel, fresh	615,600	32,950	300,690	15,929	12,367,160	628,563
Mackerel, salted					7,991,822	508,191
Menhaden, fresh	471,000	1,156	16,876,690	47,964	18,463,590	56,834
Menhaden, salted					5,800	67
Perch, white	40,400	2,395	33,635	1,525	82,335	4,740
Perch, yellow					450	30
Pickerel			8,230	530	8,230	530
Pollock, fresh	30,000	300	4,300	144	15,438,655	142,185
Pollock, salted					2,305,472	27,604
Red snapper			68,750	2,750	68,750	2,750
Salmon			18	9	60,786	13,403
Sand eels					120,000	2,000
Scup	6,833,290	160,854	396,340	13,597	7,818,530	189,429
Sea bass	247,220	13,018	132,480	7,780	475,700	26,477
Shad, fresh	30,786	2,465	479,780	26,603	1,313,212	55,733
Shad, salted					67,600	2,831
Smelt	10,600	942	2,850	432	1,138,718	104,429
Spanish mackerel	410	64			410	64
Squeteague	3,158,115	75,853	407,720	11,517	7,336,052	177,622
Striped bass	50,087	4,917	40,422	3,850	135,633	13,662
Sturgeon			6,745	482	17,980	1,349
Caviar					455	281
Suckers			122,757	4,519	126,307	4,651
Sun-fish			9,020	380	9,020	380
Sword-fish	126,900	6,743	165,930	8,818	1,689,740	118,320
Tautog	278,150	9,279	111,135	4,537	605,570	20,253
Tomcod	2,400	90	27,330	1,188	216,270	4,289
Whiting	104,500	1,319	31,270	461	2,513,470	9,812
Other fish	170,100	532			198,700	738
Squid	93,850	2,531	37,535	538	5,496,461	28,409
Crabs, hard	6,400	400			6,400	400
Crabs, soft	9,386	1,760			9,386	1,760
Lobsters	397,305	39,488	371,650	40,719	14,756,495	1,336,572
Shrimp	1,200	240			7,200	1,740
Quahogs or hard clams	217,240	35,456	151,416	24,762	1,223,200	191,357
Clams (soft), fresh	264,900	32,514	224,600	26,743	7,350,270	378,773
Clams (soft), salted					995,200	35,217
Oysters, market	3,615,353	561,291	5,936,455	872,634	10,080,910	1,554,177
Oysters, seed	640,850	26,761	8,634,283	598,948	9,469,733	639,139
Scallops	119,652	25,208	14,400	3,200	645,608	132,403
Cockles and winkles					105,000	6,600
Irish moss					740,000	33,300
Sounds and tongues					269,782	20,230
Fish roe					32,756	660
Halibut fins					34,400	1,644
Livers					1,839,622	17,849
Oil, fish					185,703	8,039
Oil, whale					5,136,767	292,875
Whalebone					19,000	90,000
Total	21,613,964	1,155,701	37,832,149	1,799,381	534,075,447	12,406,284

Supplementary table showing certain of the above products in bushels and gallons.

Products.	Maine.		New Hampshire.		Massachusetts.	
	Quantity	Value.	Quantity.	Value.	Quantity.	Value.
Quahogs or hard clams. bush.					106,818	$131,139
Clams (soft), fresh.....do....	455,136	$159,269	3,000	$3,000	227,941	157,247
Clams (soft), salted....do....	99,520	35,217				
Oysters, market ....do....					75,586	120,252
Oysters, seed ....do....					27,800	13,430
Scallops ....do....	19,109	14,013			66,150	89,982
Cockles and winkles ..do....	8,500	1,000			2,000	5,600
Oil, fish ....gallons..	1,240	314			23,520	7,725
Oil, whale ....do....					684,902	292,875

Products.	Rhode Island.		Connecticut.		Total.	
	Quantity.	Value.	Quantity.	Value.	Quantity.	Value.
Quahogs or hard clams .bush.	27,155	$35,456	18,927	$24,762	152,900	$191,357
Clams (soft), fresh.....do....	26,490	32,514	22,460	26,743	735,027	378,773
Clams (soft), salted....do....					99,520	35,217
Oysters, market ....do....	516,479	561,291	848,065	872,634	1,440,130	1,554,177
Oysters, seed...........do....	91,550	26,761	1,233,469	598,948	1,352,819	639,139
Scallops ....do....	19,942	25,208	2,400	3,200	107,601	132,403
Cockles and winkles.. do....					10,500	6,600
Oil, fish ....gallons..					24,760	8,039
Oil, whale ....do....					684,902	292,875

Comparative table showing the extent of the fisheries of the New England States in 1898 and 1902.

States.	Persons engaged.				Capital invested.			
	1898.	1902.	Increase (+) or decrease (−) in 1902 compared with 1898.		1898.	1902.	Increase (+) or decrease (−) in 1902 compared with 1898.	
			Number.	Percentage.			Amount.	Percentage.
Maine.............	16,954	19,832	+2,878	+16.97	$4,013,053	$6,939,503	+$2,926,450	+72.92
New Hampshire...	154	161	+ 7	+ 4.54	52,648	42,002	− 10,646	−20.22
Massachusetts.....	14,363	14,300	− 63	− .43	13,372,902	10,811,594	− 2,561,308	−19.15
Rhode Island	1,687	2,117	+ 430	+25.48	957,142	1,014,280	+ 57,138	+ 5.96
Connecticut.......	2,473	2,840	+ 367	+14.84	1,241,291	1,201,055	− 40,236	− 3.24
Total........	35,631	39,250	+3,619	+10.15	19,637,036	20,008,434	+ 371,398	+ 1.89

States.	Products.							
	Pounds.				Value.			
	1898.	1902.	Increase (+) or decrease (−) in 1902 compared with 1898.		1898.	1902.	Increase (+) or decrease (−) in 1902 compared with 1898.	
			Amount.	Percentage.			Amount.	Percentage.
Maine.............	123,404,561	242,390,371	+118,985,810	+96.41	$2,654,919	$2,918,772	+ $263,853	+ 9.93
New Hampshire...	3,020,715	1,593,013	− 1,427,702	−47.26	48,987	50,003	+ 1,016	+ 2.07
Massachusetts.....	202,257,817	230,645,950	+ 28,388,133	+14.03	4,463,727	6,482,427	+2,018,700	+45.22
Rhode Island	32,854,396	21,613,964	− 11,240,432	−34.21	955,058	1,155,701	+ 200,643	+21.00
Connecticut.......	31,920,417	37,832,149	+ 5,911,732	+18.52	1,559,599	1,799,381	+ 239,782	+15.37
Total........	393,457,906	534,075,447	+140,617,541	+35.73	9,682,290	12,406,284	+2,723,994	+28.13

NOTE.—Revision of the statistics on pages 130-131 of the report of the Commissioner of Fisheries for 1904 has resulted in some changes. The corrected figures appear in the present tables.

FISHERIES OF MAINE.

The number of persons employed in the coast fisheries of Maine in 1902 was 19,832. Of these, 2,017 were on fishing vessels, 310 on transporting vessels, 6,880 on boats in the shore fisheries, and 10,625 were shoresmen, chiefly in wholesale fish establishments, sardine canneries, and smokehouses. Compared with 1898 the returns for 1902 show an increase of 2,878 persons, or 16.97 per cent.

The total investment in the fisheries of the state was $6,939,503, an increase since 1898 of $2,926,450, or 72.92 per cent. The number of vessels employed was 585, valued at $722,490, with a net tonnage of 8,970 tons, and outfits valued at $227,542; the number of boats in the shore fisheries was 6,297, valued at $305,181; the value of the fishing apparatus used on vessels and boats was $476,332; the value of shore and accessory property, $3,745,483; and the cash capital amounted to $1,462,475.

The products of the fisheries aggregated in weight 242,390,371 pounds, valued at $2,918,772, an increase over the returns for 1898 of 118,985,810 pounds, or 96.41 per cent in quantity, and $263,853, or 9.93 per cent, in value. The yield comprised a large number of species, the more important of which, with the quantity and value of each, including fresh and cured fish, were cod, 17,390,464 pounds, $376,676; cusk, 2,492,517 pounds, $33,508; haddock, 7,003,240 pounds, $124,992; hake, 18,775,755 pounds, $144,891; pollock, 5,376,371 pounds, $49,123; halibut, 209,771 pounds, $14,195; herring, 162,404,266 pounds, $510,189; mackerel, 1,723,370 pounds, $101,490; sword-fish, 642,784 pounds, $44,613; alewives, 2,389,453 pounds, $21,732; salmon, 60,768 pounds, $13,394; shad, 848,999 pounds, $28,959; smelt, 1,125,268 pounds, $103,055; eels, 221,050 pounds, $12,683; lobsters, 12,163,389 pounds, $1,066,407; clams, 554,656 bushels, $194,486; and scallops, 19,109 bushels, $14,013. The secondary products, as caviar, fish roe, livers, sounds or swim-bladders, tongues, and oil were also of considerable importance, having a total value of $38,370.

Cod.—The yield of cod in this state in 1902 was slightly larger than in 1898. Practically the entire catch was taken on trawl and hand lines. In some localities the fishermen have gill nets, with which profitable catches were taken in former years, but in recent years the run of cod inshore has fallen off so much that net fishing is seldom profitable. The presence of squid is also said to interfere with the use of nets in the cod fishery. More than one-third of the entire catch of cod in 1902 was taken by vessels on the Grand Banks. These fish are usually sold in a salted condition.

Cusk.—The catch of cusk in 1902 was more than twice as large as in 1898. It is taken with hand and trawl lines in both the vessel and shore

fisheries, but principally in the former, and the greater part of the catch is sold fresh.

Haddock.—The catch of haddock has fallen off considerably since 1898. The greater part of the yield is sold fresh, the price being slightly lower than for cod.

Hake.—With the exception of herring, the catch of hake was greater than that of any other species, and shows a noticeable increase since 1898. This fish is taken generally during the summer and fall. Considerable revenue is derived from the sale of the sounds, or swim-bladders; the fishermen claim that on an average 100 pounds of hake produce 2 pounds of sounds.

Pollock.—The catch of pollock in 1902 was more than twice as large as in 1898, having increased from 2,129,450 pounds, valued at $19,364, to 5,376,371 pounds, valued at $49,123. Pollock are taken generally during the summer season, on hand lines.

Halibut.—This species is taken on hand and trawl lines. The catch was comparatively small in both the vessel and shore fisheries and was sold fresh. Most of the halibut taken in the shore fisheries are of small size and are known as "chicken halibut."

Herring.—The greater part of the herring catch is utilized in the sardine canneries and smokehouses in Washington and Hancock counties. Compared with 1898 the returns for 1902 show an increase in the catch in all the counties except Lincoln and Waldo. The increase in Washington county was from 18,205,050 pounds, valued at $119,154, in 1898, to 132,804,116 pounds, valued at $353,848, in 1902. For the entire state the increase was from 42,156,964 pounds in 1898, valued at $263,477, to 162,404,266 pounds in 1902, valued at $510,189. Besides being prepared as sardines and smoked, large quantities of herring are also sold to fishing vessels for bait. Many are frozen for this purpose.

Mackerel.—The catch of mackerel in 1902 shows a slight increase over that of 1898, probably owing to the use of a larger quantity of apparatus. The principal forms of apparatus used were seines, gill nets, and pound nets. The fishery is prosecuted generally during the summer months, very few vessels making the long trip south for mackerel in the spring.

Sword-fish.—The season for taking this species is usually from July 1 to August 15. Owing to the long distance to the fishing grounds, only large vessels, carrying crews of 6 to 10 men, are employed in the fishery. The vessels are mostly engaged in trawling during the remainder of the year. Compared with 1898 the catch of sword-fish in 1902 decreased 235,506 pounds in quantity, and increased $218 in value.

Alewives.—Several of the towns in Maine own alewife privileges, which, during favorable seasons, prove quite remunerative. In some

cases the town operates the fishery, and in others sells it to the highest bidder, who agrees to supply each poll-tax payer a certain number of fish at a nominal price. Alewives are sold fresh, salted, and smoked. The related species, usually known as "bluebacks" in this section, is also taken in considerable quantities along the coast and sold for bait and fertilizer. It is of good quality when fresh, but, owing to its extreme fatness, is difficult to cure. In the state as a whole this species is less plentiful than the alewife previously referred to, but is more abundant in certain localities.

Salmon.—The salmon fishery is prosecuted in the Penobscot River and Bay. A few salmon are taken also in the Kennebec River and elsewhere along the coast. The apparatus of capture consists chiefly of weirs, trap nets, and gill nets. Compared with 1898 the salmon catch shows an increase of 7,446 pounds in quantity, and $3,385 in value.

Shad.—This species is taken in various localities along the coast of the state, but more than 75 per cent of the catch is from the Kennebec River, where the fishery is of commercial importance as far up as Hallowell. The fishing apparatus employed in 1902 consisted principally of pound nets, trap nets, weirs, gill nets, and seines. The quantity of shad taken by vessels fishing in the ocean and bays was 50,400 pounds, valued at $2,071, and by boats in the shore fisheries, 798,599 pounds, valued at $26,888. The greater part of the catch is sold fresh by the fishermen. Since 1898 the yield has decreased slightly in quantity, but has increased 46.61 per cent in value.

Smelt.—This species is the object of a very important fishery during the fall and winter. In the fall seines are used for the most part, but in the winter the fish is taken through the ice on lines which are usually operated some distance up the rivers. Owing to the high price received for smelt, many men lay aside their regular occupations during a short time in the winter to engage in this fishery. As a rule, each fisherman has a shanty ranging in size from 4 feet square to 5 by 10 feet. In a few instances two men occupy one shanty. A small stove keeps the interior comfortable, and the lines, ordinarily about 40 feet long, with one hook, though sometimes with two, are lowered through an oblong opening in the floor of the shanty which fits over a hole of corresponding size made in the ice. The season for ice-fishing is from November to March, the farther up the river the longer the season. The smelt fishery proved so profitable in some localities during the fall of 1902 that an increased number of men fitted up gear for the following season.

Eels.—In some localities the eel fishery is of considerable importance. The catch is taken chiefly in pots. A few traps, some of which cost as much as $25, also were used. The greater part of the catch was dressed and sold fresh.

Menhaden.—This species was not abundant along the coast of Maine in 1902, and the menhaden factories of the state were not operated, except for utilizing a few fish in the preparation of oil and fertilizer at Boothbay Harbor, in Lincoln County. The remainder of the catch, both fresh and salted, was sold by the fishermen for bait.

Lobsters.—The lobster catch of this state has increased from 11,183,-294 pounds, valued at $992,855, in 1898, to 12,163,389 pounds, valued at $1,066,407, in 1902. There was also a small increase in the quantity of apparatus employed. The laws of the state do not restrict the catching of lobsters to any time in the year, but in some localities the fishermen have agreed among themselves upon a close season during the spring and summer, and thus far the effect upon the fishery has been favorable. Lobsters are taken in both the vessel and shore fisheries, but principally in the latter. In Lincoln County, however, a large number of small vessels fish for lobsters when not engaged in line-fishing. With the exception of a few lobsters caught in hoop nets in York County, the entire catch is taken in pots.

Clams.—The catch of clams shows a decided falling off since 1898, and in view of this the state has enacted protective laws applying to the localities where the decline has been greatest. Owing to the increasing number of clam canneries the demand for clams is steadily growing. The greater part of the catch is sold fresh, both in the shell and opened, and the remainder is opened and salted for use as bait in the line-fisheries.

Oysters.—A few oysters are found in the Sheepscot River near Sheepscot, but they have never occurred in sufficient quantities to justify making a business of catching them, although it is said that they have recently been increasing in number.

Livers.—The saving of livers sometimes proves quite remunerative to the line fishermen. In the vessel fisheries the livers from cod and other species are sometimes saved by the cook or other members of the crew of the vessel, the captain and owner, as a rule, not sharing in the proceeds of their sale. It is estimated that on an average a thousand pounds of fresh fish taken on lines will produce 75 pounds of livers. The livers are valuable for their oil, which is used for lubricating machinery, mixing paint, etc. A considerable quantity of the oil from cod livers, when refined, is used for medicinal purposes.

Markets.—There are a number of localities on the coast of Maine at which the fishermen dispose of their catch, but Portland is the principal market for both fish and lobsters. Many of the firms in the lobster trade own or charter steam and sail vessels which are sent along the coast of the state to buy lobsters and bring them to Portland for shipment. Several of the firms also own lobster pounds at various places, in which small lobsters are kept until they grow to marketable size and large ones are held for better prices. These pounds cost from

$1,500 to $7,000 each. Portland also receives a large part of the catch of ground-fish and other species taken by vessels, although many of the larger vessels sometimes land their fares in Boston.

The herring catch in Washington and Hancock counties is for the most part disposed of locally at the sardine canneries and smoke-houses.

The following tables give statistics of the fisheries of Maine in condensed form for the year 1902:

Persons employed.

How engaged.	Number.
On vessels fishing	2,017
On vessels transporting	810
In shore or boat fisheries	6,880
Shoresmen	10,625
Total	19,832

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	454	$489,085	Apparatus—shore fisheries—continued.		
Tonnage	6,838		Fyke nets	21	$182
Outfit		193,346	Dip nets	277	926
Vessels transporting	131	233,405	Hoop nets	9	7
Tonnage	2,132		Bag nets	221	9,245
Outfit		84,196	Seines	179	9,535
Boats	6,297	305,181	Lines, hand and trawl		16,037
Apparatus—vessel fisheries:			Eel pots and traps	671	631
Gill nets	1,873	15,388	Lobster pots	148,232	155,226
Seines	50	16,137	Fish traps	1	25
Lines, hand and trawl		26,694	Cunner traps	26	72
Eel pots	92	43	Dredges	86	1,076
Lobster pots	18,205	18,526	Spears	98	127
Harpoons		1,467	Hoes	1,855	1,516
Dredges	10	150	Shore and accessory property		3,745,483
Hoes	50	47	Cash capital		1,462,475
Apparatus—shore fisheries:					
Pound nets, trap nets, and weirs	780	189,077	Total		6,939,503
Gill nets	1,430	14,198			

Table of products.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh			1,006,853	$6,955	1,006,853	$6,955
Alewives, salted			862,750	4,875	862,750	4,875
Alewives, smoked			519,850	9,902	519,850	9,902
Butter-fish			7,780	382	7,780	382
Cat-fish	293,333	$2,730	186,100	1,272	479,433	4,002
Cod, fresh	6,489,413	129,961	4,413,497	79,820	10,902,910	209,781
Cod, salted	6,131,704	156,124	355,850	10,771	6,487,554	166,895
Cunners	633	22	60,120	1,156	60,753	1,178
Cusk, fresh	2,128,005	27,755	206,142	2,616	2,334,147	30,371
Cusk, salted	153,870	3,045	4,500	92	158,370	3,137
Eels	17,700	1,000	203,350	11,683	221,050	12,683
Flounders	30,779	622	538,141	11,329	568,920	11,951
Haddock, fresh	3,849,488	75,269	2,792,588	45,046	6,642,076	120,315
Haddock, salted	270,539	3,337	90,625	1,340	361,164	4,677
Hake, fresh	14,226,909	94,654	2,597,999	28,554	16,824,908	123,208
Hake, salted	1,629,722	16,634	321,125	5,049	1,950,847	21,683
Halibut	149,548	10,024	60,223	4,171	209,771	14,195

Table of products—Continued.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Herring, fresh	7,359,000	$39,295	150,860,500	$403,062	158,219,500	$442,357
Herring, salted	2,232,500	27,953	672,666	9,579	2,905,166	37,532
Herring, smoked			1,279,600	30,300	1,279,600	30,300
Mackerel, fresh	1,173,855	67,167	216,515	12,423	1,390,370	79,590
Mackerel, salted	333,000	21,900			333,000	21,900
Menhaden, fresh	240,000	1,800	900	5	240,900	1,805
Menhaden, salted	2,000	10	3,800	57	5,800	67
Perch, white			400	30	400	30
Perch, yellow			450	30	450	30
Pollock, fresh	1,692,694	14,197	2,640,678	22,532	4,333,372	36,729
Pollock, salted	798,624	8,346	244,375	4,048	1,042,999	12,394
Salmon			60,768	13,394	60,768	13,394
Sculpin			8,100	56	8,100	56
Shad, fresh	600	25	780,799	26,103	781,399	26,128
Shad, salted	49,800	2,046	17,800	785	67,600	2,831
Smelt	72,200	4,002	1,053,068	99,053	1,125,268	103,055
Striped bass			15,715	2,050	15,715	2,050
Sturgeon			4,700	495	4,700	495
Caviar			455	281	455	281
Suckers			3,550	132	3,550	132
Sword-fish	642,784	44,613			642,784	44,613
Tomcod	1,030	32	183,510	2,489	184,540	2,521
Whiting			91,500	147	91,500	147
Refuse fish	20,500	150			20,500	150
Lobsters	1,458,157	130,461	10,705,232	935,946	12,163,389	1,066,407
Clams, fresh	102,600	3,120	4,448,760	156,149	a 4,551,360	159,269
Clams, salted	27,000	1,125	968,200	34,092	b 995,200	35,217
Scallops	33,440	4,240	81,216	9,773	c 114,656	14,013
Winkles			85,000	1,000	d 85,000	1,000
Fish roe	4,806	84	11,250	45	16,056	129
Livers	1,459,447	13,775	380,175	4,074	1,839,622	17,849
Sounds	196,654	15,123	53,675	4,387	250,329	19,510
Tongues	4,987	124	2,900	163	7,887	287
Oil			9,300	314	e 9,300	314
Total	53,277,321	920,765	189,113,050	1,998,007	242,390,371	2,918,772

a 455,136 bushels. b 99,520 bushels. c 19,109 bushels. d 8,500 bushels. e 1,240 gallons.

THE FISHERIES BY COUNTIES.

The coast fisheries of Maine in 1902 were prosecuted in 10 counties. These were Washington, Hancock, Penobscot, Waldo, Knox, Lincoln, Kennebec, Sagadahoc, Cumberland, and York.

In 1902 Washington County had 10,122 persons engaged in the various branches of the fisheries and related industries, the greater number of them employed in sardine canneries and smokehouses. In this county the investment was $3,702,346, and the products amounted to 141,584,618 pounds, valued at $733,449. The most important species taken were herring and lobsters.

Hancock County ranks second in the importance of its fisheries—the number of persons employed being 3,670, the investment $1,067,275, and the products 33,675,426 pounds, valued at $714,075. The yield consisted chiefly of cod, hake, herring, smelt, clams, and lobsters.

Lincoln County ranks third in the number of persons engaged in the fisheries, fourth in the amount of capital invested, and fifth in the value of fishery products. It is the most westerly county of the state in which sardines are canned. Most of the canneries are located at Boothbay Harbor, a town of about 2,000 inhabitants, situated near the mouth of the Damariscotta River. Besides the herring used in the

canneries, large quantities are also sold for bait to fishing vessels from Boston, Gloucester, and other ports along the coast. The species taken in largest quantities in this county are cod, hake, herring, mackerel, smelt, lobster, and clam.

Cumberland County also has extensive fisheries, which center chiefly at Portland, where the fishermen market the greater part of their catch. The products consist principally of cod, haddock, hake, mackerel, sword-fish, lobsters, and clams. Compared with 1898 there has been considerable decrease in the catch of some of these species. The decline in the clam catch has been so great that in some localities a close season has been established with a view to improving the condition of the fishery. The catch of mackerel has increased in both quantity and value; the catch of sword-fish, while it has decreased in quantity, has increased in value.

Knox County is third among the counties of Maine in the quantity and value of its fishery products, and fifth in the number of persons employed and capital invested in the fisheries. There has been considerable increase since 1898 in the catch of cod, haddock, herring, and lobsters, but a decrease in a number of other species, especially in clams.

The most important of the 5 remaining counties were Sagadahoc, in which the number of persons employed was 471, the investment $59,368, and the products 3,732,101 pounds, valued at $85,216; and York, with 482 persons employed, $97,193 invested, and products amounting to 7,804,284 pounds, valued at $182,596.

The following tables show the extent of the fisheries in each county of Maine in 1902:

Table showing the number of persons employed in the fisheries of Maine in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Cumberland	427	57	756	385	1,625
Hancock	682	33	1,813	1,142	3,670
Kennebec			27		27
Knox	311	48	717	287	1,363
Lincoln	289	19	878	719	1,905
Penobscot	4		52	17	73
Sagadahoc	44	1	405	21	471
Waldo			94		94
Washington	150	152	1,772	8,048	10,122
York	110		366	6	482
Total	2,017	310	6,880	10,625	19,832

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Maine in 1902.

Items.	Cumberland.		Hancock.		Kennebec.		Knox.		Lincoln.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	73	$121,400	175	$143,390			69	$54,125	60	$95,050
Tonnage	1,482		2,486				880		1,043	
Outfit		25,475		96,751				32,757		14,415
Vessels transporting	20	62,400	17	36,200			22	27,750	7	16,600
Tonnage	347		162				291		147	
Outfit		4,795		5,615				5,270		1,410
Boats	597	30,219	1,653	66,583	21	$210	798	52,438	726	29,425
Apparatus—vessel fisheries:										
Gill nets	986	6,889	347	4,478			98	650	123	810
Seines	18	6,380	7	1,375			9	1,357	15	6,925
Lines, hand and trawl		8,929		5,124				4,086		3,380
Eel pots	18	9	55	22						
Lobster pots	795	795	9,565	9,565			2,975	3,191	2,180	2,180
Harpoons		1,270						40		12
Dredges			10	150						
Hoes	2	2	41	41					7	4
Apparatus—shore fisheries:										
Pound nets, trap nets, and weirs	32	6,490	187	30,007	3	500	44	17,425	69	29,005
Gill nets	95	872	42	228	29	190	74	796	89	623
Fyke nets	12	84	3	18					6	80
Dip nets			16	44			24	48	5	2
Bag nets			56	2,700					2	200
Seines	29	1,890	61	2,880			27	1,820	45	1,900
Lines, hand and trawl		4,466		3,480				1,902		1,236
Eel pots and traps	100	94	104	47			18	5	8	29
Lobster pots	12,627	12,627	33,355	33,355			39,479	44,293	23,430	23,430
Cunner traps	23	65								
Dredges	6	24	65	975			2	30		
Spears	36	54	34	26			4	12	24	35
Hoes	333	234	703	636			140	127	218	130
Shore and accessory property		367,500		398,985		75		155,853		255,180
Cash capital		163,200		224,600				158,150		96,000
Total		826,163		1,067,275		975		562,125		578,061

Items.	Penobscot.		Sagadahoc.		Waldo.		Washington.		York.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	2	$450	13	$6,900			44	$26,770	18	$41,000	454	$489,085
Tonnage	12		123				421		391		6,838	
Outfit		215		1,920				13,878		7,935		193,346
Vessels transporting			1	65			64	90,390			131	233,405
Tonnage			5				1,180				2,132	
Outfit				15				17,091				34,196
Boats	31	330	267	9,335	99	$1,548	1,824	102,771	281	12,322	6,297	305,181
Apparatus—vessel fisheries:												
Gill nets			60	420			30	300	229	1,841	1,873	15,388
Seines									1	100	50	16,137
Lines, hand and trawl		12		820				1,282		3,061		26,694
Eel pots			19	12							92	43
Lobster pots			355	355			2,155	2,155	180	285	18,205	18,526
Harpoons				50						95		1,467
Dredges											10	150
Hoes											50	47
Apparatus—shore fisheries:												
Pound nets, trap nets, and weirs	2	120	116	17,370	64	5,475	261	81,935	2	750	780	189,077
Gill nets	33	255	173	1,370	1	5	546	7,228	348	2,631	1,430	14,198
Fyke nets											21	182
Dip nets	25	75	3	1			204	756			277	926
Hoop nets									9	7	9	7
Bag nets	24	1,425	12	310	28	1,400	99	3,210			221	9,245

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Maine in 1902—Continued.

Items.	Penobscot.		Sagadahoc.		Waldo.		Washington.		York.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Apparatus—shore fisheries—Con.												
Seines	....	....	4	$185	....	....	11	$460	2	$400	179	$9,535
Lines, hand and trawl	....	....	.....	1,255	....	....	......	2,211	.....	1,487	....	16,037
Eel pots and traps	....	....	241	403	....	....	200	53	.....	....	671	631
Lobster pots	....	....	2,173	2,173	382	$457	30,966	30,966	5,820	7,925	148,232	155,226
Fish traps	....	....	1	25	....	....	......	....	.....	....	1	25
Cunner traps	....	....	.....	....	....	....	......	....	3	7	26	72
Dredges	....	....	.....	....	....	....	13	47	.....	....	86	1,076
Spears	....	....	.....	....	....	....	......	....	.....	....	98	127
Hoes	....	....	71	44	17	15	233	228	140	102	1,855	1,516
Shore and accessory property	....	$18,805	.....	12,640	....	1,410	......	2,520,940	.....	14,095	....	3,745,483
Cash capital	....	14,000	.....	3,700	....	....	......	799,675	.....	3,150	....	1,462,475
Total	....	35,687	.....	59,368	....	10,310	......	3,702,346	.....	97,193	....	6,939,503

Table showing, by counties, the products of the fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Kennebec.		Knox.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	33,600	$215	112,683	$1,132	2,750	$36	219,000	$1,272
Alewives, salted	....	....	....	....	....	....	160,000	1,200
Alewives, smoked	....	....	95,650	1,574	....	....	125,950	2,649
Butter-fish	4,600	268	....	....	....	....	....	....
Cat-fish	297,600	1,616	....	....	....	....	3,983	179
Cod, fresh	2,567,200	49,214	2,243,318	39,935	....	....	2,474,328	37,744
Cod, salted	....	....	4,498,402	111,200	....	....	207,602	3,841
Cunners	53,300	925	....	....	....	....	633	22
Cusk, fresh	670,550	9,864	97,116	1,173	....	....	1,124,976	13,760
Cusk, salted	....	....	110,165	2,341	....	....	46,520	760
Eels, fresh	15,500	991	28,590	1,429	....	....	7,500	670
Flounders	30,340	671	479,750	9,937	....	....	38,258	781
Haddock, fresh	2,813,750	53,396	677,412	9,333	....	....	1,025,159	13,924
Haddock, salted	....	....	117,459	1,427	....	....	68,305	779
Hake, fresh	2,987,250	24,748	4,647,777	20,169	....	....	3,046,406	27,239
Hake, salted	....	....	1,303,839	13,496	....	....	94,588	823
Halibut	33,410	1,839	39,398	2,688	....	....	12,393	893
Herring, fresh	1,281,800	6,212	9,299,725	47,045	....	....	7,429,125	29,853
Herring, salted	133,000	1,332	2,221,000	27,757	....	....	59,400	972
Herring, smoked	98,000	530	....	....	....	....	15,000	240
Mackerel, fresh	746,500	39,437	39,271	3,421	....	....	55,684	3,361
Mackerel, salted	179,000	11,000	....	....	....	....	4,000	400
Menhaden, salted	4,600	50	....	....	....	....	....	....
Pollock, fresh	1,093,825	8,091	438,954	3,422	....	....	670,008	3,955
Pollock, salted	....	....	707,674	7,103	....	....	7,010	70
Salmon	95	13	23,308	5,003	....	....	....	....
Sculpin	6,900	50	1,200	6	....	....	....	....
Shad, fresh	23,300	796	....	....	31,400	1,189	1,600	64
Shad, salted	49,600	1,995	5,000	220	....	....	....	....
Smelt	163,650	10,457	302,887	27,199	....	....	85,700	5,727
Striped bass	....	....	....	....	300	30	....	....
Sword-fish	522,970	36,376	....	....	....	....	34,814	2,437
Tomcod	19,545	609	20,000	257	....	....	13,400	134
Whiting	88,500	135	....	....	....	....	....	....
Lobsters	1,000,000	97,210	3,243,000	275,013	....	....	2,992,419	259,264
Clams, fresh	1,155,406	45,679	1,805,990	53,675	....	....	573,200	16,896
Clams, salted	54,000	1,200	775,560	28,955	....	....	....	....
Scallops	3,200	415	103,200	12,578	....	....	376	35
Fish roe	....	....	....	....	....	....	4,806	84
Livers	565,925	4,465	175,760	2,377	....	....	508,207	7,089
Sounds	59,836	3,540	56,206	4,082	....	....	62,998	5,590
Tongues	....	....	5,132	128	....	....	....	....
Total	16,756,752	413,369	33,675,426	714,075	34,450	1,255	21,173,348	442,707

Table showing by counties the products of the fisheries of Maine in 1902—Continued.

Species.	Lincoln.		Penobscot.		Sagadahoc.		Waldo.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	366,300	$2,330			156,200	$1,032	9,100	$91
Alewives, salted	48,000	500						
Alewives, smoked	73,600	1,490			100,900	2,051	9,350	185
Butter-fish					3,150	110		
Cat-fish	39,100	195			40,000	220		
Cod, fresh	1,175,100	29,116	11,500	$230	619,800	8,725	150	3
Cod, salted	1,154,900	35,300			2,800	100		
Cusk, fresh	199,360	2,306			51,300	670		
Cusk, salted	500	12						
Eels, fresh	36,900	2,672			107,700	5,725		
Flounders	7,800	234			3,000	30	800	8
Haddock, fresh	401,150	4,689	5,000	100	159,100	2,090		
Haddock, salted	3,200	75						
Hake, fresh	2,639,300	19,210	5,000	100	492,300	4,061		
Hake, salted	89,400	2,145			1,600	55		
Halibut	6,180	490			2,500	206		
Herring, fresh	7,970,100	36,005			718,400	3,505		
Herring, salted					22,000	275		
Herring, smoked	1,600	130						
Mackerel, fresh	363,500	22,475			70,550	3,770		
Mackerel, salted	150,000	10,500						
Menhaden, fresh	240,000	1,800						
Menhaden, salted					1,200	17		
Perch, white					400	30		
Perch, yellow					450	30		
Pollock, fresh	308,650	4,135	11,000	110	140,800	944	2,000	40
Pollock, salted	68,700	1,510			3,450	135		
Salmon			2,428	536	1,776	406	20,046	4,411
Shad, fresh	155,700	4,792			480,850	15,738		
Shad, salted	7,800	371			4,000	200		
Smelt	180,635	19,351	35,360	2,968	45,060	4,670	30,466	2,659
Striped bass	1,000	162			14,255	1,842		
Sturgeon					4,700	495		
Caviar					455	281		
Suckers					3,550	132		
Sword-fish	6,000	300			4,500	300		
Tomcod	18,800	217	8,500	113	7,200	141	17,195	292
Lobsters	1,150,850	109,820			199,850	19,293	6,562	764
Clams, fresh	345,410	15,780			150,700	5,952	28,500	1,454
Clams, salted					57,000	930		
Fish roe	11,250	45						
Livers	160,700	1,274			52,900	436		
Sounds	33,550	2,160			7,705	619		
Tongues	2,400	150						
Oil	9,000	300						
Total	17,426,435	332,041	78,788	4,157	3,732,101	85,216	124,169	9,907

Species.	Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	98,500	$710	8,720	$107	1,006,853	$6,955
Alewives, salted	654,750	3,175			862,750	4,875
Alewives, smoked	114,400	1,953			519,850	9,902
Butter-fish			30	4	7,780	382
Cat-fish			98,750	1,792	479,433	4,002
Cod, fresh	490,114	10,587	1,321,400	34,227	10,902,910	209,781
Cod, salted	579,400	14,608	44,450	1,846	6,487,554	166,895
Cunners			6,820	231	60,753	1,178
Cusk, fresh	3,245	41	187,600	2,557	2,334,147	30,371
Cusk, salted	1,185	24			158,370	3,137
Eels, fresh	24,500	1,180	360	16	221,050	12,683
Flounders	8,972	290			568,920	11,951
Haddock, fresh	377,880	6,604	1,182,625	30,179	6,642,076	120,315
Haddock, salted	171,175	2,361	1,025	35	361,164	4,677
Hake, fresh	258,990	6,381	2,747,885	21,300	16,824,908	123,208
Hake, salted	456,195	4,878	5,225	286	1,950,847	21,683
Halibut	78,650	5,032	37,240	3,047	209,771	14,195
Herring, fresh	131,219,350	317,652	301,000	2,085	158,219,500	442,357
Herring, salted	419,766	6,796	50,000	400	2,905,166	37,532
Herring, smoked	1,165,000	29,400			1,279,600	30,300
Mackerel, fresh			114,865	7,126	1,390,370	79,590
Mackerel, salted					333,000	21,900
Menhaden, fresh			900	5	240,900	1,805
Menhaden, salted					5,800	67
Perch, white					400	30
Perch, yellow					450	30

Table showing by counties the products of the fisheries of Maine in 1902—Continued.

Species.	Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pollock, fresh	1,304,035	$11,880	364,100	$4,152	4,333,372	$36,729
Pollock, salted	216,740	2,548	39,425	1,028	1,042,999	12,394
Salmon	13,115	3,025			60,768	13,394
Sculpin					8,100	56
Shad, fresh	67,599	3,531	950	18	781,399	26,128
Shad, salted	1,200	45			67,600	2,831
Smelt	281,510	30,024			1,125,268	103,055
Striped bass			160	16	15,715	2,050
Sturgeon					4,700	495
Caviar					455	281
Suckers					3,550	132
Sword-fish			74,500	5,200	642,784	44,613
Tomcod	79,900	758			184,540	2,521
Whiting			3,000	12	91,500	147
Refuse fish			20,500	150	20,500	150
Lobsters	2,956,908	252,248	613,800	52,795	12,163,389	1,066,407
Clams, fresh	317,500	11,504	144,654	8,329	a 1,551,360	159,269
Clams, salted	108,640	4,132			b 995,200	35,217
Scallops	7,880	985			c 114,656	14,013
Winkles			85,000	1,000	d 85,000	1,000
Fish roe					16,056	129
Livers	49,330	599	326,800	1,609	1,839,622	17,849
Sounds	7,831	489	22,200	3,020	250,329	19,510
Tongues	355	9			7,887	287
Oil			300	14	e 9,300	314
Total	141,584,618	733,449	7,804,284	182,596	242,390,371	2,918,772

a 455,136 bushels. b 99,520 bushels. c 19,109 bushels. d 8,500 bushels. e 1,240 gallons.

THE PRODUCTS BY APPARATUS.

Lobster pots were the most important apparatus of capture used in the fisheries of Maine in 1902, with respect both to the value of the catch and the number of persons engaged. There is also more capital invested in them than in any other apparatus except pound nets, trap nets, and weirs. In most instances the pots are set singly instead of by the use of ground lines. The catch taken with pots, including those set for eels, amounted to 12,334,629 pounds, valued at $1,075,630.

The catch with hand and trawl lines, which was next in value to that with pots, was 53,895,369 pounds, valued at $807,799. Trawl lines are fished in the fall, winter, and spring, but when the warm weather begins and dog-fish make their appearance the trawls are discontinued and hand lines are employed. During recent years dog-fish have been a great source of annoyance to the trawl fishermen, as they destroy the bait and also attack the fish on the hooks. Thus far they have had practically no market value, but experiments are being made with the view of utilizing them for food. A firm in Nova Scotia has recently canned some of them. The fishermen advocate the enactment of a law providing for the payment of a small bounty by the general government for their capture.

A trawl usually has from 2,000 to 3,000 hooks, placed about 4 feet apart, and in ordinary weather it is allowed to remain set from three to six hours. In fishing the trawls are in some instances "underrun;" that is, instead of being hauled aboard the boat the fish are taken off,

the hooks are again baited, and the line is returned to the water to continue fishing. This is done a number of times, or as long as fish are being taken in satisfactory quantities, before the line is removed from the water. Line fishing is followed in both the vessel and shore fisheries, but the catch in the former is much greater than in the latter. The species taken in largest quantities with hand and trawl lines are cod, haddock, and hake. The sounds or swim-bladders of the hake add materially to the value of that species.

Pound nets, trap nets, and weirs took 145,845,269 pounds of various species, valued at $479,347. Of this quantity 143,719,800 pounds, valued at $406,186, consisted of herring, most of which were taken in Washington County, where they were used chiefly in the sardine canneries and smokehouses.

Hoes and dredges are used in both the vessel and shore fisheries, the former exclusively in taking clams and the latter in taking scallops. The catch with these two forms of apparatus, including 85,000 pounds of winkles, worth $1,000, picked by hand, was 5,746,216 pounds, exclusive of shells, and was worth $209,499.

In the seine fisheries the yield was 11,548,835 pounds, valued at $143,962. Mackerel and herring were the principal species taken with seines in the vessel fisheries and smelt in the shore fisheries.

The catch with gill nets in the vessel and shore fisheries was 4,344,304 pounds, valued at $103,635. The most important species taken were mackerel, herring, shad, and salmon. The average length of the nets employed is from about sixty to one hundred yards each. Cod gill nets are used to only a limited extent, as in recent years they have proved unprofitable. They average about sixty yards in length, and are set on the bottom and kept in place by buoys and anchors. The floats, of which each net requires eighteen to twenty-five to support it, are of glass, and cost 18 cents each. The nets are set from 1½ to 8 miles from shore, being moved to the latter distance as the season advances.

A number of less important forms of apparatus, as fyke nets, dip nets, hoop nets, bag nets, traps, spears, and harpoons, were employed in the fisheries of this state, the catch in the aggregate amounting to 8,675,749 pounds, valued at $98,900.

The following tables present, by apparatus of capture, the quantity and value of products taken in the vessel and shore fisheries of Maine in 1902:

Table showing by counties the yield of the seine fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Knox.		Lincoln.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Flounders	290	$11	13,550	$289	6,300	$126		
Herring, fresh	835,000	3,855	375,000	1,500	1,620,000	6,480	4,126,000	$15,975
Herring, salted			591,400	7,098				
Mackerel, fresh	206,100	10,452			22,000	1,400	293,000	18,500
Mackerel, salted	179,000	11,000			4,000	400	150,000	10,500
Menhaden							240,000	1,800
Pollock	3,500	25						
Shad, salted	42,000	1,675					7,800	371
Smelt	62,000	3,090	3,400	312	5,000	400	1,800	200
Tomcod	1,030	32						
Total	1,328,920	30,140	983,350	9,199	1,657,300	8,806	4,818,600	47,346
Shore fisheries:								
Alewives	3,000	30			180,000	960		
Eels	200	16						
Flounders	14,925	320	433,300	8,835	31,625	645	7,800	234
Herring, fresh	188,000	882	76,500	360	750,000	3,000	92,000	350
Herring, salted	5,000	25						
Herring, smoked	98,000	530						
Mackerel					700	10		
Pollock	7,000	58			5,000	35	120,000	3,000
Sculpin	6,900	50						
Shad, fresh	6,400	240						
Shad, salted	7,600	320						
Smelt	97,950	7,017	100,455	6,963	48,300	2,900	101,135	7,565
Tomcod	12,015	377					500	12
Total	446,990	9,865	610,255	16,158	1,015,625	7,550	321,435	11,161
Total vessel and shore	1,775,910	40,005	1,593,605	25,357	2,672,925	16,356	5,140,035	58,507

Species.	Sagadahoc.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Flounders							20,140	$426
Herring, fresh					8,000	$200	6,964,000	28,010
Herring, salted							591,400	7,098
Mackerel, fresh							521,100	30,352
Mackerel, salted							333,000	21,900
Menhaden							240,000	1,800
Pollock							3,500	25
Shad, salted							49,800	2,046
Smelt							72,200	4,002
Tomcod							1,030	32
Total					8,000	200	8,796,170	95,691
Shore fisheries:								
Alewives	13,500	$100					196,500	1,090
Eels							200	16
Flounders			2,000	$80			489,650	10,114
Herring, fresh	3,500	25	180,000	700	120,000	600	1,410,000	5,917
Herring, salted							5,000	25
Herring, smoked			20,000	400			118,000	930
Mackerel	400	25			5,000	200	6,100	235
Pollock							132,000	3,093
Sculpin							6,900	50
Shad, fresh	1,600	50					8,000	290
Shad, salted							7,600	320
Smelt	7,300	750	5,060	607			360,200	25,802
Tomcod							12,515	389
Total	26,300	950	207,060	1,787	125,000	800	2,752,665	48,271
Total vessel and shore	26,300	950	207,060	1,787	133,000	1,000	11,548,835	143,962

Table showing by counties the yield of the gill-net fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Kennebec.		Knox.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Herring, fresh			365,000	$10,975				
Herring, salted	47,000	$700	1,563,000	19,659			16,800	$280
Mackerel	434,100	23,240	33,571	3,250			31,334	1,880
Menhaden, salted	2,000	10						
Shad, fresh	600	25						
Total	483,700	23,975	1,961,571	33,884			48,134	2,160
Shore fisheries:								
Alewives, fresh					250	$6		
Herring, fresh							13,500	190
Herring, salted	20,000	150	66,600	1,000			42,500	688
Herring, smoked							15,000	240
Mackerel	26,500	1,400					900	45
Menhaden, salted	2,600	40						
Shad, fresh	6,900	305			12,400	589	1,600	64
Shad, salted			5,000	220				
Total	56,000	1,895	71,600	1,220	12,650	595	73,500	1,227
Total vessel and shore	539,700	25,870	2,033,171	35,104	12,650	595	121,634	3,387

Species.	Lincoln.		Penobscot.		Sagadahoc.		Waldo.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Mackerel	61,700	$3,450			10,850	$545		
Total	61,700	3,450			10,850	545		
Shore fisheries:								
Alewives, fresh	800	20						
Alewives, smoked	8,000	175						
Herring, smoked	1,600	130						
Mackerel	3,000	200			3,000	255		
Menhaden, salted					1,200	17		
Perch, white					400	30		
Perch, yellow					450	30		
Salmon			2,134	$471			42	$9
Shad, fresh	43,200	1,275			79,300	3,085		
Striped bass	900	150			6,050	840		
Sturgeon					4,200	475		
Caviar					455	281		
Suckers					1,000	30		
Total	57,500	1,950	2,134	471	96,055	5,043	42	9
Total vessel and shore	119,200	5,400	2,134	471	106,905	5,588	42	9

Species.	Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Herring, fresh	30,000	$310			395,000	$11,285
Herring, salted	14,300	216			1,641,100	20,855
Mackerel			81,200	$4,450	652,755	36,815
Menhaden, salted					2,000	10
Shad, fresh					600	25
Total	44,300	526	81,200	4,450	2,691,455	68,990
Shore fisheries:						
Alewives, fresh					1,050	26
Alewives, smoked					8,000	175
Cod, fresh			1,000	28	1,000	28
Cod, salted			1,500	50	1,500	50
Herring, fresh	600,000	6,088	138,000	860	751,500	7,138
Herring, salted	342,266	5,700	50,000	400	521,366	7,938
Herring, smoked					16,600	370
Mackerel			27,300	2,385	60,700	4,285
Menhaden, salted					3,800	57
Perch, white					400	30
Perch, yellow					450	30

Table showing by counties the yield of the gill-net fisheries of Maine in 1902—Continued.

Species.	Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries—Continued.						
Salmon	2,202	$549			4,378	$1,029
Shad, fresh	86,000	3,460	900	$15	230,300	8,793
Shad, salted	1,200	45			6,200	265
Smelt	33,000	2,655			33,000	2,655
Striped bass					6,950	990
Sturgeon					4,200	475
Caviar					455	281
Suckers					1,000	30
Total	1,064,668	18,497	218,700	3,738	1,652,849	34,645
Total, vessel and shore	1,108,968	19,023	299,900	8,188	4,344,304	103,635

Table showing by counties the yield of the fyke-net fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Lincoln.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Flounders	11,000	$275	4,900	$196			15,900	$471
Sculpin			1,200	6			1,200	6
Smelt					500	$60	500	60
Tomcod					16,800	160	16,800	160
Total	11,000	275	6,100	202	17,300	220	34,400	697

Table showing by counties the yield of the pound-net, trap-net, and weir fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Kennebec.		Knox.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	30,600	$215	112,683	$1,132	2,500	$30	9,000	$180
Alewives, smoked			95,650	1,574			105,000	2,100
Butter-fish	4,600	268						
Herring, fresh	258,800	1,475	8,243,225	33,550			5,045,625	20,183
Herring, salted	61,000	457					100	4
Mackerel	79,800	4,345	5,700	171			750	26
Pollock, fresh	22,700	93						
Salmon	95	13	23,308	5,003				
Shad, fresh	9,400	226			19,000	600		
Smelt	3,700	350	31,146	3,159				
Striped bass					300	30		
Tomcod	6,500	200	4,100	93				
Whiting	88,500	135						
Total	565,695	7,777	8,515,812	44,682	21,800	660	5,160,475	22,493

Species.	Lincoln.		Penobscot.		Sagadahoc.		Waldo.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh	2,500	$45			73,500	$579	9,100	$91
Alewives, smoked	53,600	1,115			100,900	2,051	9,350	185
Butter-fish					3,150	110		
Cod							150	3
Flounders					3,000	30		
Herring, fresh	3,752,100	19,680			714,900	3,480		
Herring, salted					22,000	275		
Mackerel	5,800	325			56,300	2,945		
Pollock, fresh	24,000	60					2,000	40
Pollock, salted	6,700	200						
Salmon			294	$65	1,776	406	20,004	4,402
Shad, fresh	112,500	3,517			399,950	12,603		
Shad, salted					4,000	200		
Smelt	2,700	335			8,335	850		
Striped bass					8,205	1,002		
Sturgeon					500	20		
Suckers					2,550	102		
Tomcod	300	5			200	3		
Total	3,960,200	25,282	294	65	1,399,266	24,656	40,604	4,721

Table showing by counties the yield of the pound-net, trap-net, and weir fisheries of Maine in 1902—Continued.

Species.	Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:						
Alewives, fresh	55,500	$405	8,720	$107	304,103	$2,784
Alewives, salted	202,500	1,075			202,500	1,075
Alewives, smoked	42,000	805			406,500	7,830
Butter-fish			30	4	7,780	382
Cod			100	5	250	8
Cunners			20	1	20	1
Flounders	1,200	36			4,200	66
Herring, fresh	124,378,850	296,777	35,000	425	142,428,500	375,570
Herring, salted	63,200	880			146,300	1,616
Herring, smoked	1,145,000	29,000			1,145,000	29,000
Mackerel			1,215	81	149,565	7,893
Menhaden			900	5	900	5
Pollock, fresh	38,080	380			86,780	573
Pollock, salted					6,700	200
Salmon	9,453	2,146			54,930	12,035
Shad, fresh	1,575	69	50	3	542,475	17,018
Shad, salted					4,000	200
Smelt	162,930	16,480			208,811	21,174
Striped bass					8,505	1,032
Sturgeon					500	20
Suckers					2,550	102
Tomcod	31,800	815			42,900	616
Whiting			3,000	12	91,500	147
Total	126,132,088	348,368	49,035	643	145,845,269	479,347

Table showing by counties the catch with dip nets, hoop nets, and bag nets in Maine in 1902.

Species.	Hancock.		Knox.		Lincoln.		Penobscot.		Sagadahoc.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Val.
Shore fisheries:										
Alewives, fresh			30,000	$132	363,000	$2,265			62,000	$308
Alewives, salted			160,000	1,200	48,000	500				
Alewives, smoked			20,950	549	12,000	200				
Flounders	2,200	$24								
Herring	240,000	660								
Smelt	69,200	6,896	11,100	888	1,300	150	35,360	$2,968	3,875	365
Striped bass					100	12				
Tomcod	15,900	164	2,300	23	1,200	40	8,500	113	7,000	138
Total	327,300	7,744	224,350	2,792	425,600	3,167	43,860	3,081	72,875	811

Species.	Waldo.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives, fresh			43,000	$305			498,000	$3,010
Alewives, salted			452,250	2,100			660,250	3,800
Alewives, smoked			72,400	1,148			105,350	1,897
Flounders	800	$8	50	2			3,050	34
Herring			6,030,500	13,777			6,270,500	14,437
Salmon			200	20			200	20
Shad			24	2			24	2
Smelt	30,466	2,659	80,520	10,282			231,821	24,208
Striped bass							100	12
Tomcod	17,195	292	48,100	443			100,195	1,213
Lobsters					500	$50	500	50
Total	48,461	2,959	6,727,044	28,079	500	50	7,869,990	48,683

Table showing by counties the yield of the hand and trawl line fisheries of Maine in 1902.

Species.	Cumberland.		Hancock.		Knox.		Lincoln.		Penobscot.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Cat-fish	150,900	$865			1,083	$52	39,100	$195		
Cod, fresh	1,304,800	28,303	1,193,218	$20,150	1,899,113	29,310	950,200	23,169	11,500	$230
Cod. salted			4,394,402	108,645	207,602	3,841	1,053,300	31,565		
Cunners					633	22				
Cusk, fresh	545,050	8,292	91,216	1,089	1,088,684	13,290	196,260	2,269		
Cusk, salted			106,165	2,261	46,520	760				
Flounders	3,000	15	5,300	111	333	10				
Haddock, fresh	1,763,250	35,832	167,012	2,053	536,974	6,535	333,250	3,837	5,000	100
Haddock, salted			101,359	1,249	68,305	779				
Hake, fresh	2,390,950	20,358	4,052,270	11,859	2,185,246	18,999	2,567,200	18,575	5,000	100
Hake, salted			1,163,839	11,948	94,588	823				
Halibut	27,705	1,381	22,065	1,717	9,363	664	5,580	445		
Pollock, fresh	451,975	3,978	200,854	1,765	530,892	3,248	131,000	820	11,000	110
Pollock, salted			660,674	6,633	7,010	70	3,800	35		
Livers	493,125	3,883	139,380	1,856	358,412	5,096	143,200	1,134		
Sounds	51,421	3,153	39,185	2,991	45,684	4,207	28,210	1,146		
Tongues			4,632	115						
Fish roe					4,806	84				
Total	7,182,176	106,060	12,341,571	174,442	7,085,248	87,790	5,451,100	83,190	32,500	540
Shore fisheries:										
Cat-fish	146,700	751			2,900	127				
Cod, fresh	1,262,400	20,911	1,050,100	19,785	575,215	8,434	224,900	5,947		
Cod, salted			104,000	2,555			101,600	3,735		
Cusk, fresh	125,500	1,572	5,900	84	36,292	470	3,100	37		
Cusk, salted			4,000	80			500	12		
Flounders			9,900	198						
Haddock, fresh	1,050,500	17,564	510,400	7,280	488,185	7,389	67,900	852		
Haddock, salted			16,100	178			3,200	75		
Hake, fresh	596,300	4,390	595,507	8,310	861,160	8,240	72,100	635		
Hake, salted			140,000	1,548			89,400	2,145		
Halibut	5,705	458	17,333	971	3,030	229	600	45		
Pollock, fresh	608,650	3,937	238,100	1,657	134,116	672	33,650	255		
Pollock, salted			47,000	470			58,200	1,275		
Smelt			98,686	9,869	21,300	1,539	73,200	11,041		
Tom cod					11,100	111				
Livers	72,800	582	36,380	521	149,795	1,993	17,500	140		
Sounds	8,415	387	17,021	1,091	17,314	1,383	5,340	1,014		
Tongues			500	13			2,400	150		
Fish roe							11,250	45		
Oil							9,000	300		
Total	3,876,970	50,552	2,890,927	54,610	2,300,407	30,587	773,840	27,703		
Total, vessel and shore	11,059,146	156,612	15,232,498	229,052	9,385,655	118,377	6,224,940	110,893	32,500	540

Species.	Sagadahoc.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Cat-fish	20,000	$120			82,250	$1,498	293,333	$2,730
Cod, fresh	167,500	2,790	142,132	$3,115	820,950	22,894	6,489,413	129,961
Cod, salted			468,400	11,758	8,000	315	6,131,704	156,124
Cunners							633	22
Cusk, fresh	27,200	370	745	16	178,850	2,429	2,128,005	27,755
Cusk, salted			1,185	24			153,870	3,045
Flounders			2,006	60			10,639	196
Haddock, fresh	71,800	1,035	72,222	1,715	899,980	24,162	3,849,488	75,269
Haddock, salted			100,875	1,309			270,539	3,337
Hake, fresh	243,400	1,990	100,008	2,266	2,682,835	20,507	14,226,909	94,654
Hake, salted			369,195	3,708	2,100	155	1,629,722	16,634
Halibut	1,675	131	48,750	2,923	34,410	2,763	149,548	10,024
Pollock, fresh	35,000	270	129,273	1,971	199,200	2,010	1,689,194	14,172
Pollock, saltèd			125,240	1,533	1,900	75	798,624	8,346
Refuse fish					20,500	150	20,500	150
Livers	30,900	262	17,630	185	276,800	1,359	1,459,447	13,775
Sounds	3,640	313	6.814	358	21,700	2,955	196,654	15,123
Tongues			355	9			4,987	124
Fish roe							4,806	84
Total	601,115	7,281	1,584,830	30,950	5,229,475	81,272	39,508,015	571,525
Shore fisheries:								
Cat-fish	20,000	100			16,500	294	186,100	1,272
Cod, fresh	452,300	5,935	347,982	7,472	496,850	11,250	4,409,747	79,734
Cod, salted	2,800	100	111,000	2,850	34,950	1,481	354,350	10,721

Table showing by counties the yield of the hand and trawl line fisheries of Maine in 1902—Continued.

Species.	Sagadahoc.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries—Con.								
Cunners					1,700	$55	1,700	$55
Cusk, fresh	24,100	$300	2,500	$25	8,750	128	206,142	2,616
Cusk, salted							4,500	92
Eels					360	16	360	16
Flounders			3,716	112			13,616	310
Haddock, fresh	87,300	1,055	305,658	4,889	282,645	6,017	2,792,588	45,046
Haddock, salted			70,300	1,052	1,025	35	90,625	1,340
Hake, fresh	248,900	2,071	158,982	4,115	65,050	793	2,597,999	28,554
Hake, salted	1,600	55	87,000	1,170	3,125	131	321,125	5,049
Halibut	825	75	29,900	2,109	2,830	284	60,223	4,171
Mackerel					150	10	150	10
Pollock, fresh	105,800	674	1,136,682	9,529	164,900	2,142	2,421,898	18,866
Pollock, salted	3,450	135	91,500	1,015	37,525	953	237,675	3,848
Salmon			1,260	310			1,260	310
Smelt	25,550	2,705					218,736	25,154
Striped bass					160	16	160	16
Tom cod							11,100	111
Livers	22,000	174	31,700	414	50,000	250	380,175	4,074
Sounds	4,065	306	1,020	131	500	75	53,675	4,387
Tongues							2,900	163
Fish roe							11,250	45
Oil					300	14	9,300	314
Total	998,690	13,685	2,379,200	35,193	1,167,320	23,944	14,387,354	236,274
Total, vessel and shore	1,599,805	20,966	3,964,030	66,143	6,396,795	105,216	53,895,309	807,799

Table showing by counties the catch with spears in Maine in 1902.

Counties.	Eels.		Flounders.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cumberland	10,200	$650			10,200	$650
Hancock	9,900	495	10,600	$284	20,500	779
Knox	3,500	350			3,500	350
Lincoln	24,600	1,848			24,600	1,848
Total	48,200	3,343	10,600	284	58,800	3,627

Table showing by counties the catch of sword-fish with harpoons in the vessel fisheries of Maine in 1902.

Counties.	Lbs.	Value.
Cumberland	522,970	$36,376
Knox	34,814	2,437
Lincoln	6,000	300
Sagadahoc	4,500	300
York	74,500	5,200
Total	642,784	44,613

Table showing by counties the catch with cunner traps and fish traps in Maine in 1902.

Species.	Cumberland.		Sagadahoc.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives			7,200	$45			7,200	$45
Cod					2,500	$50	2,500	50
Cunners	53,300	$925			5,100	175	58,400	1,100
Eels	550	35					550	35
Flounders	1,125	50					1,125	50
Total	54,975	1,010	7,200	45	7,600	225	69,775	1,280

Table showing by counties the catch with hoes and dredges in Maine in 1902.

Species.	Cumberland.		Hancock.		Knox.		Lincoln.		Sagadahoc.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Clams, fresh	3,650	$100	79,000	$2,370	....	....	19,950	$650	....	....
Clams, salted	....	....	27,000	1,125	....	....	....	....	....	....
Scallops	....	....	33,440	4,240	....	....	....	....	....	....
Total	3,650	100	139,440	7,735	....	....	19,950	650	....	....
Shore fisheries:										
Clams, fresh	1,151,756	45,579	1,726,990	51,305	573,200	$16,896	325,460	15,130	150,700	$5,952
Clams, salted	54,000	1,200	718,560	27,830	....	....	....	....	57,000	930
Scallops	3,200	415	69,760	8,338	376	35	....	....	....	....
Total	1,208,956	47,194	2,545,310	87,473	573,576	16,931	325,460	15,130	207,700	6,882
Total, vessel and shore	1,212,606	47,294	2,684,750	95,208	573,576	16,931	345,410	15,780	207,700	6,882

Species.	Waldo.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Clams, fresh	....	....	....	....	....	....	102,600	$3,120
Clams, salted	....	....	....	....	....	....	27,000	1,125
Scallops	....	....	....	....	....	....	33,440	4,240
Total	....	....	....	....	....	....	163,040	8,485
Shore fisheries:								
Clams, fresh	28,500	$1,454	347,500	$11,504	144,654	$8,329	4,448,760	156,149
Clams, salted	....	....	108,640	4,132	....	....	968,200	34,092
Scallops	....	....	7,880	985	....	....	81,216	9,773
Winkles	....	....	....	....	*a* 85,000	1,000	85,000	1,000
Total	28,500	1,454	464,020	16,621	229,654	9,329	5,583,176	201,014
Total, vessel and shore	28,500	1,454	464,020	16,621	229,654	9,329	5,746,216	209,499

a Taken by hand.

Table showing by counties the catch with eel pots, eel traps, and lobster pots in Maine in 1902.

Species.	Cumberland.		Hancock.		Knox.		Lincoln.		Sagadahoc.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Eels	2,000	$150	13,000	$650	....	....	....	....	2,700	$200
Lobsters	44,700	4,475	809,245	70,596	304,067	$28,584	123,800	$11,575	12,250	1,100
Total	46,700	4,625	822,245	71,246	304,067	28,584	123,800	11,575	14,950	1,300
Shore fisheries:										
Eels	2,550	140	5,690	284	4,000	320	12,300	824	105,000	5,525
Lobsters	955,300	92,735	2,433,755	204,417	2,688,352	230,680	1,027,050	98,245	187,600	18,193
Total	957,850	92,875	2,439,445	204,701	2,692,352	231,000	1,039,350	99,069	292,600	23,718
Total, vessel and shore	1,004,550	97,500	3,261,690	275,947	2,996,419	259,584	1,163,150	110,644	307,550	25,018

Species.	Waldo.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Eels	....	....	....	....	....	....	17,700	$1,000
Lobsters	....	....	144,795	$12,031	19,300	$2,100	1,458,157	130,461
Total	....	....	144,795	12 031	19,300	2,100	1,475,857	131,461

Table showing by counties the catch with eel pots, eel traps, and lobster pots in Maine in 1902—Continued.

Species.	Waldo.		Washington.		York.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Eels	....	....	24,500	$1,180	....	....	154,040	$8,273
Lobsters	6,562	$764	2,812,113	240,217	594,000	$50,645	10,704,732	935,896
Total	6,562	764	2,836,613	241,397	594,000	50,645	10,858,772	944,169
Total, vessel and shore	6,562	764	2,981,408	253,428	613,300	52,745	12,334,629	1,075,630

THE SALMON FISHERY OF PENOBSCOT RIVER AND BAY.

The number of persons employed in the salmon fishery of Penobscot River and Bay in 1902 was 126. The investment included 137 weirs, valued at $10,340; 39 trap nets, valued at $2,125; 32 gill nets, valued at $250; 185 boats, valued at $3,180; and shore and accessory property amounting in value to $2,477, a total of $18,372. The catch was 3,269 salmon in number, or 45,782 pounds, having a value to the fishermen of $9,950.

Table showing by localities the extent of the salmon fishery of Penobscot River and Bay in 1902.

Towns.	Persons employed.	Weirs and traps.		Gill nets.		Boats, scows, etc.		Shore and accessory property.	Total investment.
		No.	Value.	No.	Value.	No.	Value.		
Brooksville (Cape Rosier)	2	6	$450	......	....	2	$30	$115	$595
Bucksport	9	13	830	......	....	15	271	325	1,426
Castine	4	4	275	......	....	5	55	15	345
Hampden	3	......	....	5	$25	3	15	....	40
Islesboro	3	8	360	......	....	3	60	57	477
Lincolnville	8	13	615	......	....	8	80	200	895
Northport	3	12	700	......	....	3	75	80	855
Orland	15	23	1,105	......	....	15	150	50	1,305
Orrington	3	2	120	4	50	3	85	25	280
Penobscot	16	20	1,405	......	....	34	620	350	2,375
Searsport	4	6	1,100	......	....	6	160	100	1,360
South Brewer	4	......	....	10	50	4	40	....	90
Stockton and Prospect	15	20	2,500	......	....	27	523	430	3,453
Verona	24	44	2,805	......	....	38	711	630	4,146
Winterport	5	5	200	1	5	11	235	100	540
Localities above Bangor	8	......	....	12	120	8	70	....	190
Total	126	176	12,465	32	250	185	3,180	2,477	18,372

Towns.	Salmon caught in weirs and trap nets.			Salmon caught in gill nets.			Total catch.		
	No.	Lbs.	Value.	No.	Lbs.	Value.	No.	Lbs.	Value.
Brooksville (Cape Rosier)	80	1,120	$224	......	....	....	80	1,120	$224
Bucksport	114	1,594	367	......	....	....	114	1,594	367
Castine	102	1,428	286	......	....	....	102	1,428	286
Hampden	....	....	....	17	238	$52	17	238	52
Islesboro	98	1,372	302	......	....	....	98	1,372	302
Lincolnville	203	2,842	625	......	....	....	203	2,842	625
Northport	194	2,716	598	......	....	....	194	2,716	598
Orland	67	938	188	......	....	....	67	938	188
Orrington	21	294	65	28	392	86	49	686	151
Penobscot	607	8,498	1,700	......	....	....	607	8,498	1,700
Searsport	234	3,276	721	......	....	....	234	3,276	721
South Brewer	....	....	....	36	504	111	36	504	111
Stockton and Prospect	631	8,832	1,943	......	....	....	631	8,832	1,943
Verona	695	9,730	2,238	......	....	....	695	9,730	2,238
Winterport	69	966	213	3	42	9	72	1,008	222
Localities above Bangor	....	....	....	70	1,000	222	70	1,000	222
Total	3,115	43,606	9,470	154	2,176	480	3,269	45,782	9,950

The following table gives the number, pounds, and value of salmon taken in Penobscot River and Bay each year from 1895 to 1902, inclusive:

Years.	No.	Lbs.	Value.
1895	4,395	65,011	$11,356
1896	6,403	80,225	12,716
1897	3,985	51,522	7,911
1898	3,225	42,560	8,342
1899	3,515	45,688	10,424
1900	3,541	44,660	7,832
1901	6,821	86,055	12,263
1902	3,269	45,782	9,950

THE CANNING INDUSTRY.

The sardine industry has undergone considerable change during the the past few years. In 1899 two companies were formed, known as the "Seacoast Packing Company" and the "Standard Sardine Company," which included most of the canneries in Washington and Hancock counties. The Seacoast Packing Company eventually absorbed its younger rival, and a number of the more antiquated plants were dismantled and abandoned. Some of the canneries were fitted with new and improved machinery and were thus rendered more effective than formerly. Eleven plants at Eastport, owned by the Seacoast Packing Company, were not operated in 1902, the machinery having been removed. Early in 1903 this company was reorganized and the greater number of its canneries were sold, but the best ones at Eastport and Lubec were retained. Several of the packers who had sold their canneries to the companies regained possession of them, and consequently a considerably larger number of canneries was operated in 1903 than in 1902.

A number of the canneries now use artificial methods for drying sardines before placing them in the oven to be subjected to heat. A large rotary fan is generally employed for this purpose. After being flaked and put on the racks the fish are exposed to the current of air produced by the fan.

Can-making machinery is in use in quite a number of the canneries, and there is a large factory at North Lubec devoted wholly to the manufacture of cans. There are several kinds of can-making machines on the market, but none of them seems to be perfectly adapted for use in the sardine industry. Large sums of money have been spent in perfecting these machines, and it is expected that success will soon be achieved.

The number of canneries operated in Maine in 1902 was 75, valued at $1,000,535. The cash capital utilized in carrying on the industry amounted to $859,650. The number of persons employed in the

canneries was 8,842 and the amount of wages paid was $1,236,391. The output consisted of 1,203,970 cases of sardines, valued at $3,631,035, and other products worth $325,668, the total value being $3,956,703.

The packers are beginning to can kippered herring. The quantity canned in 1902 was 1,750 cases, valued at $8,720. There were no Russian sardines prepared, as the trade in this product has become unprofitable.

Table showing by counties the canneries, cash capital, number of persons engaged, and wages paid in the canning industry of Maine in 1902.

Counties.	Canneries.		Cash capital.	Persons engaged.	Wages paid.
	No.	Value.			
Cumberland	8	$23,535	$16,100	111	$8,000
Hancock	13	89,650	146,500	967	143,632
Knox	3	12,000	22,500	112	9,612
Lincoln	6	150,200	36,500	598	136,500
Washington	45	725,150	638,050	7,054	938,647
Total	75	1,000,535	859,650	8,842	1,236,391

Table showing by counties the products of the canning industry of Maine in 1902.

Products.	Cumberland.		Hancock.		Knox.	
	No.	Value.	No.	Value.	No.	Value.
Raw products:						
Cod ... pounds					150,000	$1,500
Herring ... do	130,000	$650	7,351,950	$27,037		
Clams ... bushels	21,120	7,925	63,375	24,691	31,000	8,300
Clams ... gallons	19,000	7,600				
Total		16,175		51,728		9,800
Manufactured products:						
Sardines in oil—						
Quarters ... cases			74,971	261,345		
Halves ... do			467	3,036		
Sardines in mustard—						
Quarters ... do			2,179	6,863		
Three-quarters ... do			32,820	112,706		
Plain herring—						
One-pound ... do	2,000	17,600	1,000	2,000		
Cod—						
One-pound ... do					2,032	4,165
Clams—						
One-pound ... do	7,490	23,778	24,918	75,452	10,229	33,343
Two-pound ... do			1,700	3,910	2,172	5,398
Clam chowder—						
One-pound ... do	100	300				
Three-pound ... do	4,400	12,250	2,000	6,600	300	810
Clam extract—						
Two-pound ... do					2,750	3,713
Total		53,928		471,912		47,429
Secondary products:						
Scrap ... pounds			362,500	450		
Total				450		
Total value of manufactured and secondary products		53,928		472,362		47,429

Table showing by counties the products of the canning industry of Maine in 1902—Cont'd.

Products.	Lincoln.		Washington.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Raw products:						
Cod........pounds..	....	....	....	....	150,000	$1,500
Herring........do....	5,130,000	$25,650	79,044,550	$261,121	91,130,450	314,458
Pollock........do....	....	....	44,800	300	44,800	300
Clams........bushels..	9,000	2,250	38,050	9,512	162,545	52,078
Clams........gallons..	....	....	....	....	19,000	7,600
Total........	....	27,900	....	270,933	....	376,536
Manufactured products:						
Sardines in oil—						
Quarters........cases..	52,300	178,821	701,964	2,149,849	829,235	2,590,015
Halves........do....	1,000	4,500	1,500	9,000	2,967	16,536
Sardines in mustard—						
Quarters........do....	2,274	7,390	15,133	47,668	19,586	61,921
Halves........do....	....	....	337	1,348	337	1,348
Three-quarters........do....	22,300	74,030	294,486	766,134	349,606	952,870
Sardines in spices—						
Three-quarters........do....	500	1,750	639	2,445	1,139	4,195
Sardines in tomato sauce—						
Quarters........cases..	....	....	100	400	100	400
Three-quarters........do....	1,000	3,750	....	....	1,000	3,750
Plain herring—						
One-pound........do....	....	....	....	....	3,000	19,600
Two-pound........do....	....	....	1,500	1,875	1,500	1,875
Three-pound........do....	....	....	300	720	300	720
Kippered herring—						
1¼-pound oval........do....	....	....	1,750	8,720	1,750	8,720
Skinned and boneless herring—						
One-pound, round..cases..	....	....	900	2,000	900	2,000
Smoked herring—						
Bloaters........boxes..	....	....	2,400	1,800	2,400	1,800
Lengthwise........do....	....	....	10,400	988	10,400	988
Medium........do....	....	....	214,600	25,752	214,600	25,752
Pickeled herring........barrels..	....	....	3,460	15,570	3,460	15,570
Pollock, salted........pounds..	....	....	33,600	750	33,600	750
Cod—						
One-pound........cases..	....	....	....	....	2,032	4,165
Clams—						
One-pound........do....	3,000	9,000	8,700	28,960	54,337	170,533
Two-pound........do....	....	....	1,600	3,300	5,472	12,668
Clam juice—						
One-pound........do....	....	....	500	1,200	500	1,200
Clam chowder—						
One-pound........do....	....	....	....	....	100	300
Three-pound........do....	....	....	500	1,650	7,200	21,310
Clam extract—						
Two-pound........do....	....	....	....	....	2,750	3,713
Total........	....	279,241	....	3,070,189	....	3,922,699
Secondary products:						
Oil........gallons..	....	....	92,750	18,550	92,750	18,550
Pomace........tons..	....	....	1,290	14,900	1,290	14,900
Scrap........pounds..	....	....	242,500	104	605,000	554
Total........	....	....	....	33,554	....	34,001
Total value of manufactured and secondary products....	....	279,241	....	3,103,743	....	3,956,703

Number of canneries engaged in each branch of canning in Maine in 1902.

Counties.	Sardine.	Herring.	Cod.	Clams.	Total. [a]
Cumberland........	....	2	....	8	8
Hancock........	6	1	....	9	13
Knox........	....	....	1	3	3
Lincoln........	5	....	....	1	6
Washington........	41	6	....	3	45
Total........	52	9	1	24	75

[a] Number of canneries in each county without duplication.

THE SMOKED-FISH INDUSTRY.

The smoked-fish industry of Maine in 1902, exclusive of sardine canners and fishermen who smoke large quantities of herring and other species, was carried on by 81 firms or establishments. The number of persons engaged was 923; the value of smokehouses and other shore and accessory property utilized was $294,340; the cash capital was $175,575; the amount of wages paid was $108,401, and the value of the products prepared was $365,923.

Table showing the number of firms, persons engaged, wages paid, and capital invested in the smoked-fish industry of Maine in 1902.

Counties.	Number of firms.	Persons engaged.	Wages.	Value of shore and accessory property.	Cash capital.
Cumberland	4	59	$23,100	$109,150	$21,500
Hancock and Knox	3	14	450	1,075	1,250
Lincoln	3	43	4,700	13,875	6,000
Washington and Penobscot	71	807	80,151	170,240	146,825
Total	81	923	108,401	294,340	175,575

Table showing by counties the products of the smoked-fish industry of Maine in 1902.

Products.	Cumberland.		Hancock and Knox.		Lincoln.		Washington and Penobscot.		Total.	
	No.	Val.	No.	Val.	No.	Val.	No.	Val.	No.	Val.
Raw products:										
Alewives ...pounds			56,250	$568					56,250	$568
Cod ...do	5,000	$125							5,000	125
Haddock ...do	1,285,000	30,150	19,400	255			141,793	$2,730	1,446,193	33,135
Hake ...do	10,000	200							10,000	200
Halibut ...do	1,000	100	1,500	80					2,500	180
Herring ...do	100,000	750			1,215,000	$9,575	18,620,500	64,203	19,935,500	74,528
Herring, salted do			5,000	75					5,000	75
Total	1,401,000	31,325	82,150	978	1,215,000	9,575	18,762,293	66,933	21,460,443	108,811
Manufactured products:										
Smoked alewives, pounds			45,000	1,125					45,000	1,125
Smoked cod pounds	2,500	150							2,500	150
Smoked halibut, pounds	800	112	1,000	110					1,800	222
Smoked hake ...lbs	7,000	420							7,000	420
Smoked haddock—Finnan haddie, pounds	704,000	46,180	9,700	679			107,700	8,202	821,400	55,061
Smoked herring—										
Bloaters ...boxes	500	400	100	150	14,000	14,250	34,060	25,546	48,660	40,346
Lengthwise .do					1,000	110	56,870	5,935	57,870	6,045
Medium ...do					25,000	3,320	1,582,890	182,766	1,607,890	186,086
Small ...do	7,000	1,050							7,000	1,050
Boneless ...do	10,000	18,000							10,000	18,000
No. 1 ...do					2,000	185			2,000	185
Skinned and boneless ...pounds							40,000	3,600	40,000	3,600
Pickled herring, barrels							11,654	52,420	11,654	52,420
Total		66,312		2,064		17,865		278,469		364,710
Secondary products:										
Oil ...gallons							2,550	510	2,550	510
Pomace ...tons							55	660	55	660
Scrap ...pounds							85,000	43	85,000	43
Total								1,213		1,213
Total of manufactured and secondary products		66,312		2,064		17,865		279,682		365,923

SMOKED HERRING.

The herring smoked by the fishermen are shown as smoked herring in the product tables, but the American-caught herring, smoked by canners and regular smokers and included as smoked herring in the statistics of the canning and smoked-herring industries, appear as fresh herring in the product tables, since that was the condition in which they were sold by the fishermen.

The following table gives the quantity and value of smoked herring prepared by fishermen, canners, and regular smokers in Maine in 1902:

Table showing the quantity and value of smoked herring prepared in Maine in 1902.

Designation.	Pounds.	Value.
Smoked by fishermen	1,279,600	$30,300
Smoked by canners	1,446,000	28,540
Smoked by regular smokers	12,184,960	255,312
Total	14,910,560	314,152

Table showing the quantity and value of smoked herring prepared in Maine in various years from 1880 to 1902.

Years.	Pounds.	Value.	Years.	Pounds.	Value.
1880	4,434,111	$99,973	1892	10,151,695	$232,036
1887	3,419,485	100,488	1898	10,671,170	185,836
1888	4,360,435	140,154	1902	14,910,560	314,152
1889	5,090,425	159,330			

Table showing the number of firms, persons engaged, amount of capital invested, and wages paid in the wholesale fishery trade of Maine in 1902, not included in the canned and smoked-fish industries.

Counties.	Number of firms.	Value of shore and accessory property.	Cash capital.	Persons engaged.	Wages paid.
Cumberland	21	$211,330	$113,500	103	$44,400
Hancock	22	61,200	77,350	107	12,300
Knox	15	92,824	135,150	154	53,433
Lincoln	5	45,650	38,500	36	9,400
Penobscot, Sagadahoc, and York	4	21,750	14,400	28	10,824
Washington	7	15,370	18,450	42	7,100
Total	74	448,124	397,350	470	137,457

FISHERIES OF NEW HAMPSHIRE.

The coast fisheries of New Hampshire are of minor importance when compared with those of other New England States, and are confined to Rockingham County, the only county in the state bordering the seacoast. The number of persons employed in the fisheries of New Hampshire in 1902 was 161, of whom 25 were on fishing vessels, 122 on boats in the shore fisheries, and 14 were shoresmen. The amount of capital invested was $42,002, including 4 fishing vessels, with a total net tonnage of 55 tons, valued at $2,150, and the value of their

outfit, $3,075; 115 boats, valued at $7,270; fishing apparatus on vessels and boats, valued at $11,137; shore property, $10,370, and cash capital, $8,000. The products of the vessel and shore fisheries aggregated 1,593,013 pounds, for which the fishermen received $50,003.

The statistics for 1902 compared with those for 1898 show a large decrease in the quantity, but a slight increase in the value of the fishery products. The decrease is almost wholly in the line fisheries, both vessel and shore. The total catch with this form of apparatus in 1902 was 757,450 pounds, against 2,454,950 pounds in 1898. The great decline in the line fisheries was due in a large measure to the ravages of the dog-fish, which appeared in increasing numbers on the coast, devouring many of the food fish and driving others away, thus practically putting an end to the line fishing. In some localities trawl-line fishing has been abandoned entirely, and but little hand-line fishing is undertaken.

The products of the vessel fisheries in 1902 aggregated 386,350 pounds, with a value of $12,500. Of the various species taken, cod represented nearly half of the entire catch, amounting to 150,000 pounds, with a value of $4,500. The catch of mackerel has more than doubled since the last canvass, and in value leads that of any other species taken in the vessel fisheries.

The yield of the shore fisheries was 1,206,663 pounds, with a value of $37,503. As in the vessel fishery, cod is the leading species in the number of pounds taken, and is next to lobsters in the value of the catch.

The lobster fishery has increased considerably in importance since 1898 and is now the most valuable fishery in the state, the catch in 1902 amounting to 128,463 pounds, with a value of $14,863. The fishermen employed numbered 56, using 46 boats valued at $1,510 and 7 launches valued at $2,800.

The season for catching lobsters lasts about five or six months, depending somewhat on the weather. Usually the season begins between April 15 and May 1 and continues until September 30 or the middle of October.

The various localities where the fishery is prosecuted are Rye Beach, Great Boars Head, Little Boars Head, North Beach, Hampton Beach and Hampton River, Rye Harbor, Isle of Shoals, Newcastle, and Portsmouth.

At Hampton Beach 12 men were engaged in the fishery, setting 480 pots, and the catch amounted to 12,857 pounds, valued at $1,800. The depth of water fished in varies from 6 to 7 fathoms inshore, and from 10 to 14 fathoms outside. The pots are set from 2 to 5 miles offshore.

Between Hampton and North Beach, including Little Boars Head and Great Boars Head, 275 pots were fished by 7 men, the catch amounting to 9,649 pounds, valued at $965.

At Rye Beach and Rye Harbor 340 pots were fished by 7 men, the catch being 15,975 pounds, valued at $1,598.

At "North Beach," or North Hampton Beach, 6 men were engaged in the fishery, using 290 pots, valued at $580; the catch amounted to 15,000 pounds, valued at $1,500.

At the Isle of Shoals, in New Hampshire, 4 men fished 250 pots, valued at $250, and caught 16,666 pounds, valued at $2,000.

At Portsmouth and Newcastle there were 20 fishermen with 895 pots, and the catch amounted to 58,322 pounds, valued at $7,000. Of this quantity over 40,000 pounds, valued at $5,000, was taken by the Portsmouth fishermen.

The fishery for Irish moss (*Chondrus crispus*) in New Hampshire is prosecuted at Rye Harbor by Mr. William H. Burke, of Scituate, Mass., who had in his employ 6 men, using 8 boats valued at $240. The quantity of moss cured in 1902 was 50,000 pounds, valued at $2,250. The plant at Rye Harbor is modern and well equipped for the business. Instead of the cumbersome method formerly employed of rolling the tubs about the beach to the water's edge when it became necessary to wash the moss, a pumping plant has been erected to furnish the water as needed, a hose of sufficient length being attached and carried to any part of the beach upon which the tubs containing the moss may be placed, thus effecting a great saving in time and labor in this part of the work. A small gasoline launch is used to tow the boats to and from the grounds where the moss is gathered.

The following tables present in a condensed form the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of New Hampshire in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	25
In shore or boat fisheries	122
Shoresmen	14
Total	161

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels fishing	4	$2,150	Apparatus—shore fisheries—Continued.		
Tonnage	55		Lines, hand and trawl		$371
Outfit		3,075	Lobster pots	2,530	3,535
Boats	115	7,270	Eel pots	15	15
Apparatus—vessel fisheries:			Hoes	12	6
Lines, trawl		560	Rakes	6	30
Harpoons		10	Shore property		10,370
Seines	2	700	Cash capital		8,000
Gill nets	15	150			
Apparatus—shore fisheries:					
Pound nets and weirs	24	5,760	Total		42,002

Table of products.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh			100,000	$1,000	100,000	$1,000
Alewives, salted			250,000	2,813	250,000	2,813
Cod	150,000	$4,500	291,600	7,480	441,600	11,980
Cusk	20,000	400			20,000	400
Eels			5,000	200	5,000	200
Haddock	67,000	1,625	92,200	1,573	159,200	3,198
Hake	10,350	175	38,500	485	48,850	660
Herring			100,000	1,000	100,000	1,000
Mackerel, fresh	70,000	3,700	10,000	800	80,000	4,500
Mackerel, salted	15,000	900			15,000	900
Perch, white			1,600	160	1,600	160
Pollock	50,000	800	107,800	1,654	157,800	2,454
Striped bass			1,500	225	1,500	225
Sword-fish	4,000	400			4,000	400
Lobsters			128,463	14,863	128,463	14,863
Clams, soft			30,000	3,000	a 30,000	3,000
Irish moss			50,000	2,250	50,000	2,250
Total	386,350	12,500	1,206,663	37,503	1,593,013	50,003

a 3,000 bushels.

THE PRODUCTS BY APPARATUS.

The greater part of the vessel catch was taken with trawl lines, and consisted of cod, cusk, haddock, hake, and pollock, amounting to 297,350 pounds, valued at $7,500. Gill nets took 8,000 pounds of mackerel, $480, and seines 77,000 pounds of that species, $4,120. Harpoons took 4,000 pounds of sword-fish, worth $400.

In the shore fisheries the catch with hand and trawl lines was 460,100 pounds, valued at $9,992; with pound nets and weirs, 533,100 pounds, valued at $7,198; with rakes and hoes, 80,000 pounds, valued at $5,250; and with lobster and eel pots, 133,463 pounds, valued at $15,063.

The products of the vessel and shore fisheries, with each form of apparatus, are shown separately in the following tables:

Table showing the yield of the vessel fisheries of New Hampshire in 1902.

Apparatus and species.	Lbs.	Value.	Apparatus and species.	Lbs.	Value.
Gill nets:			Lines, trawl:		
Mackerel, fresh	8,000	$480	Cod	150,000	$4,500
Seines:			Cusk	20,000	400
			Haddock	67,000	1,625
Mackerel, fresh	62,000	3,220	Hake	10,350	175
Mackerel, salted	15,000	900	Pollock	50,000	800
Total	77,000	4,120	Total	297,350	7,500
Harpoons:			Grand total	386,350	12,500
Swordfish	4,000	400			

Table showing the yield of the shore fisheries in New Hampshire in 1902.

Apparatus and species.	Lbs.	Value.	Apparatus and species.	Lbs.	Value.
Pound nets and weirs:			Rakes and hoes:		
Alewives, fresh	100,000	$1,000	Clams, soft	30,000	$3,000
Alewives, salted	250,000	2,813	Irish moss	50,000	2,250
Cod	50,000	1,000			
Herring	100,000	1,000	Total	80,000	5,250
Mackerel	10,000	800			
Perch, white	1,600	160	Pots:		
Pollock	20,000	200	Lobsters	128,463	14,863
Striped bass	1,500	225	Eels	5,000	200
Total	533,100	7,198	Total	133,463	15,063
Lines, trawl and hand:			Grand total	1,206,663	37,503
Cod	241,600	6,480			
Haddock	92,200	1,573			
Hake	38,500	485			
Pollock	87,800	1,454			
Total	460,100	9,992			

FISHERIES OF MASSACHUSETTS.

The fisheries of Massachusetts in 1902 gave employment to 14,300 persons, of whom 7,546 were on vessels engaged in fishing, 32 on vessels transporting fishery products, 3,809 on boats in the shore fisheries, and 2,913 were engaged as shoresmen in the wholesale fishery trade and other branches of industry connected with the fisheries.

The amount of capital invested in the fisheries of the state was $10,811,594. This included 605 fishing and transporting vessels, valued at $2,562,351, the net tonnage of which was 32,370 tons, and the value of their outfit $1,362,708; 2,688 boats in the shore fisheries, valued at $213,963; fishing apparatus on vessels and boats to the value of $602,698; shore and accessory property valued at $3,482,374; and cash capital, $2,587,500.

The products of the fisheries aggregated 230,645,950 pounds, for which the fishermen received $6,482,427. The catch by vessels was 188,509,698 pounds, valued at $5,220,660, and by boats in the shore fisheries 42,136,252 pounds, valued at $1,261,767.

Compared with 1898, the year for which the previous canvass of the fisheries of this state was made, there has been a decrease of 63 in the number of persons employed, and of $2,561,308 in the amount of capital invested, but an increase of 28,388,133 pounds, or 14.03 per cent in the quantity, and $2,018,700, or 45.22 per cent in the value of the products. Some of the more important species in which there has been an increase in the quantity and value of the catch are alewives, from 2,535,201 pounds, $31,288, to 3,413,350 pounds, $40,979; flounders, from 1,168,876 pounds, $14,793, to 2,595,667 pounds, $80,406; haddock, from 35,581,514 pounds, $419,818, to 39,219,530 pounds, $801,868; halibut, from 10,523,297 pounds, $547,440, to 12,155,934 pounds, $648,643; herring, from 22,363,497 pounds, $332,547, to

29,235,201 pounds, $401,031; mackerel, from 6,703,364 pounds, $361,864, to 17,624,322 pounds, $980,985; pollock, from 7,084,037 pounds, $43,045, to 12,175,656 pounds, $117,768; squeteague, from 1,371,910 pounds, $39,518, to 3,770,217 pounds, $90,252; whiting or silver hake, from 37,200 pounds, $492, to 2,286,200 pounds, $7,885; clams, hard and soft, from 1,981,487 pounds, $153,318, to 3,133,954 pounds, $288,386; lobsters, from 1,693,741 pounds, $147,702, to 1,695,688 pounds, $175,095, and squid, from 1,069,425 pounds, $14,620, to 5,365,076 pounds, $25,340. The catch of cod has decreased in quantity from 71,314,978 pounds to 69,521,385 pounds, but has increased in value from $1,407,039 to $1,772,942. Hake have decreased in catch from 21,331,816 pounds to 14,357,954 pounds, and increased in value from $163,634 to $191,379. Scup have decreased from 1,043,625 pounds to 588,900 pounds in quantity, and increased from $14,253 to $14,978 in value.

The decrease in the catch of cod was reported to have been largely due to the great abundance of dog-fish along the coast, which often destroyed the trawls and the fish on them, and drove the uncaught fish from the fishing grounds.

Cod roe, and sometimes that of haddock, is shipped to France for use as bait in the sardine fisheries. The quantity of this product saved by the fishermen in 1902 as compared with the returns for 1898 has increased from 700 pounds, valued at $18, to 16,700 pounds, valued at $531.

The halibut fishery on the Atlantic coast has decreased greatly in recent years. From 1875 to 1880 the entire catch of this species in the fisheries of Massachusetts, varying from 9,000,000 to 16,000,000 pounds a year, was from fishing banks in the Atlantic Ocean. Halibut from the Pacific coast were introduced into eastern markets by the shipment of a few carloads in 1880. In 1898 a Boston firm fitted out a steamer for catching halibut in the North Pacific Ocean, and, encouraged by the success of the enterprise, in 1902 fitted out another. The total catch of halibut by Massachusetts vessels in 1902 was 12,155,934 pounds, valued at $648,643. Of this quantity 7,136,934 pounds fresh and salted, valued at $447,883, was from the Atlantic, and 5,019,000 pounds fresh, valued at $200,760, from the Pacific coast.

The mackerel catch in 1902 was taken chiefly by 108 vessels, carrying 168 purse seines. The fleet included 103 schooners and 5 steamers, 9 of the schooners having auxiliary power by the use of gasoline. In Essex County there were 87 vessels with 141 purse seines, in Suffolk County 15 vessels with 18 purse seines, in Plymouth County 2 vessels with 2 purse seines, and in Barnstable County 4 vessels with 7 purse seines. Large quantities of mackerel also were taken by vessels and boats with gill nets and hand lines, and in the pound-net and trap-net fisheries. The fish were generally large, and as a result the small

salted fish commanded high prices. In order therefore to dispose of the large fish to the best advantage, and at the same time supply the demand for those of smaller size, some of the large salted mackerel were split lengthwise and cut once or twice crosswise into 4 to 6 pieces, and packed in kits, pails, and other small packages. The experiment proved satisfactory to both dealers and consumers, the small pieces of large fish being superior in quality to the small fish. The large mackerel when dressed with heads off weighed from 2 to 3 pounds each.

Squeteague have not until recent years been abundant in the waters of Massachusetts, although a few have usually been taken in Vineyard Sound and vicinity. The catch in 1879 was 103,310 pounds. In 1883 the catch on the north side of Cape Cod, so far as reported, was represented by a single individual taken in a pound net near Provincetown. This fish was so unfamiliar to the fishermen of that locality that it was sent to Boston for identification. The catch of this species in Massachusetts in 1898, as previously noted, had increased to 1,371,910 pounds, worth $39,518, and in 1902 to 3,770,217 pounds, worth $90,252, nearly all of which was taken in Barnstable and Dukes counties. In 1902 and 1903 the pound nets in Cape Cod Bay were often filled with squeteague. The schools were large and the fish averaged about 5 pounds each in weight. The fishermen think the squeteague drive the mackerel from the shore, and they are not pleased with the change, as the mackerel is a much more valuable species.

For many years whiting or silver hake (*Merluccius bilinearis*) have been very abundant along the Massachusetts coast from June 10 to about July 10, and have reappeared in smaller numbers from the last of September to the middle of November. These fish, as taken from the water, weigh from three-fourths of a pound to 1½ and, occasionally 2 pounds each. They have been, until within a few years, mostly discarded for food or bait on account of becoming soft soon after being captured. Small quantities have at various times been pickled, and while they were quite firm, and the flesh white and of good flavor, there was little demand for them, the trade being supplied by small mackerel, which, in those years, were cheap and plentiful. In 1901 and subsequently small mackerel were very scarce, and whiting were used as a substitute. They were dressed similar to mess mackerel, by being split down the back and having the heads removed, after which they were thoroughly salted and packed in half barrels, kits, and buckets, and placed on the market under the name of white-fish, which, as a pickled fish, they somewhat resembled. A small quantity was also canned. In that year 600 barrels were pickled at Provincetown and sold to southern and western dealers. In 1902 the trade for salted whiting was much more extensive than in the previous year, and they were packed at Boston, Gloucester, and Provincetown. The quantity

caught and sold fresh, chiefly for salting purposes, in Suffolk County was 210,000 pounds, $1,575; in Essex County, 1,215,000 pounds, $3,950, and in Barnstable County, 861,200 pounds, $2,630. The entire catch, except 30,000 pounds, was taken in pound nets.

The Newfoundland herring fishery, so far as frozen herring are concerned, began in the winter of 1854–55, when a Gloucester vessel obtained part of a cargo of frozen herring from Newfoundland waters as an experiment, and sold them for bait at Boston and Gloucester. Since that time the fishery has grown to considerable proportions, and large quantities of these fish are now used both for food and bait. The fishery has been facilitated in recent years by the erection of cold-storage plants at the principal New England ports for the purpose of storing herring, squid, and other species for use as bait or food when needed. During the winter of 1902–3 the fleet from Massachusetts engaged in fishing for herring off the coast of Newfoundland numbered 59 vessels, of which 56 were from Gloucester and 3 from Boston. The winter was unusually severe and herring were scarce and difficult to locate. Eight of the vessels from Gloucester were detained for months in the bays and harbors of Newfoundland by ice. Of the 59 vessels in the fleet, 10 made two trips and the remainder one trip each. Vessels that started early in the season made quick and profitable trips, but those that started and arrived later found a poor market for bait on account of an unusual abundance of squid in Massachusetts waters. Many of the vessels failed to secure full fares, and some of those detained by ice found their cargoes unfit for food or bait and sold them to fertilizer plants for 25 cents or less a barrel, while in a few instances the fish were thrown overboard before reaching port. The catch amounted to 23,576 barrels, or 5,359,763 pounds of fresh frozen herring, valued at $118,790, and 51,220 barrels, or 11,271,698 pounds of salted herring, valued at $154,739; a total of 74,796 barrels, or 16,631,461 pounds, valued at $273,529.

The catch of squid was 5,365,076 pounds, worth $25,340. Part of this quantity was sold for bait as taken from the water, and the remainder was frozen and held in cold storage for that purpose. The cod fishermen on the Grand Banks of Newfoundland have for many years depended on catching considerable quantities of squid on or near the fishing grounds for use as bait, but in 1902 the supply failed in those waters. In view of this scarcity Capt. Solomon Jacobs, of Gloucester, before leaving on a trip for frozen herring, loaded his steam fishing vessel, the *Alice M. Jacobs*, at Provincetown, with 286,000 pounds of frozen squid, bought from the cold-storage plants at that place, and carried the cargo to St. Pierre, where it was sold to the French fishermen for bait in the Grand Bank cod fisheries. This was the first cargo of frozen squid ever taken from Massachusetts to St. Pierre or elsewhere in that vicinity.

Irish moss (*Chondrus crispus*) is an edible seaweed found in many places along the Massachusetts coast, but more particularly in the vicinity of Scituate, where the catch in 1902 amounted to 500,000 pounds, valued at $22,500. The total catch of the state was 690,000 pounds, valued at $31,050.

The apparatus used in gathering the "moss" consists of a rake made especially for this purpose, measuring 12 to 15 inches across, and having from 24 to 28 teeth 6 inches long, with a space of about an eighth of an inch between the teeth. These rakes have handles 15 or 20 feet long and are used from boats. But a small portion of the crop is gathered by hand.

The product is usually held pending orders for shipment, and therefore is distributed through a large and varied territory. The principal cities to which it is shipped are Philadelphia, New York, Boston, and Portsmouth, N. H., but it is also utilized in smaller cities throughout the United States and Canada. A small percentage of the crop is sold to wholesale druggists and grocers; the larger portion is disposed of to brewers and to firms which make a specialty of brewers' supplies, being used for clarifying and imparting body to beer. It is also used for making blanc mange and jellies, and for a variety of purposes. The price in 1902 was 4 to 4½ cents per pound, and in 1903 from 5 to 5½ cents.

The variation from year to year in the supply of Irish moss seems to be governed largely by the inclination or disinclination of fishermen to engage in the business. Some seasons a large number of persons gather the seaweed, while in other years only a few are thus employed, with a consequent increase or decrease in the product. At times, however, severe storms on the coast do a great deal of damage to the fishery, tearing the seaweed from the rocks and scattering it widespread over long stretches of the beach. The method of gathering also is destructive. In some localities the rocks are almost completely denuded, leaving such a scant growth to produce the next season's crop that the yield is necessarily light.

If the rocks are not gleaned too closely in the early part of the season it is said to be possible to get two crops in some of the warm, sheltered coves, where the plant grows much faster than in the more open and exposed places. The season extends from May until September 1, the first of the crop usually going on the market in August. It is shipped in barrels holding 100 pounds each, flour and sugar barrels being largely used for this purpose. Very little, if any, Irish moss is shipped in bales.

In the preparation and curing processes good weather and plenty of sunshine are the prime requisites. The seaweed when brought ashore is washed and then spread upon the sandy beach, where it remains for twenty-four hours, after which it is raked up, put into tubs, and given

another washing, and again spread upon the beach. Three such operations usually suffice, though at times six or seven washings are required. The seaweed is thus thoroughly cleansed and at the same time partially bleached. About two weeks' exposure in warm sunshine completes the curing process, and great care is exercised to prevent rain from spoiling the crop. When a storm is impending the moss is hastily raked into piles and covered with canvas. Should it chance to get wet in the last week of curing its market value is greatly depreciated. After the curing is completed about two weeks' time is required to sort and pick over and prepare the product for shipment.

The above information was obtained through the courtesy of Mr. William H. Burke, of Scituate, who is engaged in the Irish moss industry.

The following tables give the number of persons employed, the number and value of vessels, boats, and fishing apparatus, the value of shore and accessory property, the amount of cash capital, and the quantity and value of products taken in the vessel and shore fisheries of Massachusetts in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	7,546
On vessels transporting	32
In shore or boat fisheries	3,809
Shoresmen	2,913
Total	14,300

Table of apparatus and capital.

Items.	No.	Value.	Items.	No.	Value.
Vessels, fishing	594	$2,543,451	Apparatus—shore fisheries—Continued.		
Tonnage	31,965		Lines, hand and trawl		$12,570
Outfit *a*		1,360,323	Dip nets	155	290
Vessels, transporting	11	18,900	Beam trawls	45	1,905
Tonnage	405		Fyke nets	18	156
Outfit		2,385	Pots, lobster	25,551	35,014
Boats	2,688	213,963	Pots, eel	994	1,211
Apparatus—vessel fisheries:			Cunner nets and traps		54
Seines	178	121,500	Spears, eel	98	157
Gill nets	6,855	64,484	Weirs, eel	28	725
Pound nets	1	300	Harpoons, sword-fish		56
Lines, hand and trawl		170,309	Dredges	1,036	2,473
Beam trawls	20	1,390	Tongs, rakes, forks, and hoes	1,535	6,238
Harpoons, sword-fish		2,797	Rakes, Irish moss	140	573
Pots, lobster	825	994	Minor apparatus		138
Dredges	84	226	Shore and accessory property		3,482,374
Rakes	6	42	Cash capital		2,587,500
Minor apparatus		20	Total		10,811,594
Apparatus—shore fisheries:					
Seines	75	8,799			
Gill nets	2,216	19,827			
Pound nets and trap nets	169	150,450			

a The harpoons, guns, etc., used on whaling vessels are included with the "outfits" of vessels fishing.

Table of products.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh			1,320,350	$15,220	1,320,350	$15,220
Alewives, salted			1,979,000	24,619	1,979,000	24,619
Alewives, smoked			114,000	1,140	114,000	1,140
Blue-fish	119,400	$9,409	75,450	6,333	194,850	15,742
Bonito	32,270	1,291	134,200	4,623	166,470	5,914
Butter-fish	1,800	72	104,250	4,324	106,050	4,396
Cat-fish			2,500	50	2,500	50
Cod, fresh	37,460,512	889,910	3,198,480	86,309	40,658,992	976,219
Cod, salted	28,617,968	784,732	244,425	11,991	28,862,393	796,723
Cusk, fresh	2,737,586	42,937			2,737,586	42,937
Cusk, salted	155,721	2,573			155,721	2,573
Cunners			140,150	7,734	140,150	7,734
Dog-fish			52,800	200	52,800	200
Eels			493,644	25,322	493,644	25,322
Flounders	797,309	24,259	1,798,358	56,147	2,595,667	80,406
Haddock, fresh	37,510,732	769,154	1,117,725	24,130	38,628,457	793,284
Haddock, salted	591,073	8,584			591,073	8,584
Hake, fresh	13,687,341	182,494	192,800	2,634	13,880,141	185,128
Hake, salted	477,813	6,251			477,813	6,251
Halibut, fresh	10,979,806	578,504			10,979,806	578,504
Halibut, salted	1,176,128	70,139			1,176,128	70,139
Herring, fresh	7,899,903	153,102	9,083,000	77,951	16,982,903	231,053
Herring, salted	12,252,298	169,978			12,252,298	169,978
Hickory shad			1,650	25	1,650	25
Horse-mackerel	560	17	75,095	2,038	75,655	2,055
Mackerel, fresh	9,404,411	465,505	576,089	30,089	9,980,500	495,594
Mackerel, salted	7,643,822	485,391			7,643,822	485,391
Menhaden	430,000	2,950	445,000	2,459	875,000	5,409
Perch, white			6,300	630	6,300	630
Pollock, fresh	8,786,534	81,960	2,126,649	20,598	10,913,183	102,558
Pollock, salted	1,262,473	15,210			1,262,473	15,210
Sand eels	120,000	2,000			120,000	2,000
Scup	36,500	965	552,400	14,013	588,900	14,978
Sea bass	27,800	1,480	68,200	4,199	96,000	5,679
Shad	4,200	210	17,047	927	21,247	1,137
Squeteague	22,500	385	3,747,717	89,867	3,770,217	90,252
Striped bass	1,459	175	26,450	2,445	27,909	2,620
Sturgeon			6,535	372	6,535	372
Sword-fish	726,126	56,546	24,000	1,200	750,126	57,746
Tautog	22,500	715	190,785	5,722	213,285	6,437
Tomcod			32,000	490	32,000	490
Whiting, or silver hake			2,286,200	7,885	2,286,200	7,885
Lobsters	68,321	7,115	1,627,367	167,980	1,695,688	175,095
Shrimp			6,000	1,500	6,000	1,500
Squid			5,365,076	25,340	5,365,076	25,340
Clams, hard	11,896	1,550	842,648	129,589	[a] 854,544	131,139
Clams, soft			2,279,410	157,247	[b] 2,279,410	157,247
Oysters, market	38,500	7,332	490,602	112,920	[c] 529,102	120,252
Oysters, seed			194,600	13,430	[d] 194,600	13,430
Scallops	13,350	4,707	383,550	85,275	[e] 396,900	89,982
Cockles			20,000	5,600	[f] 20,000	5,600
Irish moss			690,000	31,050	690,000	31,050
Oil, whale	5,136,767	292,875			[g] 5,136,767	292,875
Oil, cod	172,653	7,575			[h] 172,653	7,575
Oil, dog-fish			3,750	150	[i] 3,750	150
Whalebone	19,000	90,000			19,000	90,000
Halibut fins	34,400	1,644			34,400	1,644
Tongues and sounds	11,566	433			11,566	433
Cod roe	16,700	531			16,700	531
Total	188,509,698	5,220,660	42,136,252	1,261,767	230,645,950	6,482,427

[a] 106,818 bushels.
[b] 227,941 bushels.
[c] 75,586 bushels.
[d] 27,800 bushels.
[e] 66,150 bushels.
[f] 2,000 bushels.
[g] 684,902 gallons.
[h] 23,020 gallons.
[i] 500 gallons.

THE FISHERIES BY COUNTIES.

Essex County continues to be the leading county of Massachusetts in the extent of its fisheries. The number of persons employed in 1902 was 7,106, of whom 4,630 were on fishing and transporting vessels, 943 on boats in the shore fisheries, and 1,533 were shoresmen, engaged chiefly in preparing the products for market. The amount of capital

invested was $5,319,263, including 332 vessels of 19,578 tons net tonnage, valued at $1,507,926, and their outfit, valued at $693,597; 585 boats in the shore fisheries, valued at $55,070; fishing apparatus used on vessels and boats, $285,301; shore and accessory property, $1,472,869, and cash capital, $1,304,500. The products secured by vessels and boats amounted to 132,874,503 pounds, for which the fishermen received $3,426,326. The greater part of the products was taken by vessels and boats owned at Gloucester.

The fisheries of Gloucester in 1902 employed 5,960 persons, of whom 4,278 were on vessels, 235 on boats, and 1,447 were shoresmen engaged chiefly in preparing fish for market. The investment was $4,950,796. This included, in connection with the vessel fisheries, 293 fishing vessels and 3 transporting vessels of 18,198 net tons, valued at $1,415,596, and their outfit, valued at $641,958; hand and trawl lines used by vessels, valued at $89,876; purse seines, 132, valued at $95,500; gill nets, 3,673, valued at $34,629, and sword-fish harpoons, lines, etc., worth $690. There were also 148 boats in the shore fisheries, valued at $23,165, including 15 gasoline boats, worth $9,150, used chiefly in the lobster, mackerel, and herring fisheries. The fishing apparatus on boats was valued at $25,713. The shore and accessory property and cash capital employed in the fisheries and wholesale fishery trade amounted to $2,623,669. The mackerel fleet from this port using purse seines numbered 85 vessels, 1 of which was a steamer and 7 had auxiliary power by the use of gasoline and were among the most successful of the fleet. The products of the fisheries of Gloucester in 1902 amounted to 114,424,457 pounds of fresh and salted fish, having a value to the fishermen of $3,016,152, of which 108,967,917 pounds, $2,886,920, were taken by vessels and 5,456,540 pounds, $129,232, by boats in the shore fisheries. These products were not all landed at Gloucester, however, but a part of them was sold at Boston and elsewhere. Vessels from other ports also landed considerable quantities of fish at Gloucester. The total quantity of fishery products landed at this port by American fishing vessels in 1902 as their own catch was 88,980,879 pounds, valued at $2,336,444, of which 39,614,878 pounds, $787,676, were fresh fish and 49,366,001 pounds, $1,548,768, were salted fish.

Suffolk County is next in importance, having 2,419 persons employed, 1,233 of whom were on vessels, 268 on boats, and 918 were shoresmen. The investment was $3,851,884, and included 80 vessels with a net tonnage of 4,593 tons, valued at $581,350, and the value of their outfit, $322,752; 174 boats in the shore fisheries, valued at $9,080; fishing apparatus, $83,952; shore and accessory property, $1,749,750, and cash capital, $1,105,000. The products taken in the fisheries of this county aggregated 42,466,284 pounds, having a value to the fishermen of $1,155,480, and were nearly all marketed at Boston.

The fresh fish business of Boston centers at T wharf, where, unless prevented by severe weather, vessels arrive from the fishing grounds with fares of fish practically every day in the year. The fleet owned at Boston numbered 78 vessels, but fish are also landed there by an equally large number of vessels from Gloucester, Provincetown, and other ports along the coast. Large quantities of fish are also brought by steamboats and railroad trains, and by numerous small boats in the shore fisheries.

The fresh fish landed at Boston in 1902 by vessels owned there consisted principally of 8,116,663 pounds of cod, 430,900 pounds of cusk, 17,006,950 pounds of haddock, 5,150,600 pounds of hake, 881,500 pounds of pollock, 5,076,100 pounds of halibut, 1,073,631 pounds of mackerel, and 284,000 pounds of herring, aggregating 38,020,344 pounds, having a value to the fishermen of $958,959. The catch also included fresh fish of other species and salted fish in smaller quantities. The quantity of fish landed at Boston by American fishing vessels in 1902, including those from other ports, was 78,973,996 pounds, valued at $2,042,638, of which 77,608,596 pounds, $1,994,198, were fresh, and 1,365,400 pounds, $48,440, were salted. The fish received from the various sources are shipped to dealers in the towns and cities in the New England States, to New York and other cities in the Middle Atlantic States, and as far west as Denver, Colo.

In the shore fisheries of Boston 128 Italian fishermen with 75 dories engaged in catching flounders and other species. The only forms of apparatus used were hand lines and short trawls. The fishermen occupy fishing camps on the islands in Boston Harbor some 8 miles from the city, and fish about eight months of the year. They sell their fish at the head of T wharf by the piece, bunch, or small lot, chiefly to buyers of their own nationality. In 1902 the catch consisted of flounders, 550,000 pounds, $22,000; cod, 100,000 pounds, $4,000; haddock, 45,000 pounds, $1,350; pollock, 15,000 pounds, $450; and whiting or silver hake, 30,000 pounds, $300; a total of 740,000 pounds, with a value of $28,100.

The clam fisheries in Boston Harbor are engaged in by 15 men with 10 dories. The greater part of the catch is taken during the summer, although the fishery is carried on to some extent at other seasons of the year when the weather permits. The boats usually make four trips a week and average 3 barrels of clams each to a trip. The clams are taken at low tide from the mud flats in the harbor, which are also worked more or less by a large number of fishermen who reside at the various seaside resorts in that vicinity, where they market their catch. The catch in 1902 was 11,520 bushels, valued at $5,760.

Eels are taken about eight months of the year, in and near the mouths of small streams emptying into Boston Harbor, by 15 fisher-

men with 10 dories. The method of fishing practiced is termed "bobbing." The apparatus consists of a short pole with a line attached, by which is suspended a ball of fine twine interwound with angleworms. The eels, in their attempt to secure the worms, entangle their teeth in the twine and are quickly drawn into the boat.

The cunner fishery from Boston in 1902 was carried on near the islands in Boston Harbor by 9 fishermen with 3 boats. The catch was taken with hoop nets, or fyke nets, and amounted to 38,400 dozen, or 57,600 pounds of cunners, valued at $3,840. The boats made two trips a week during eight months of the year, and averaged 200 dozen cunners each to a trip. The fish were of small size, weighing about 2 ounces each, and sold for an average of 10 cents a dozen. These boats are the last of the "Irish market boats," being about 4 tons each and similar to those used in Ireland. Formerly from 30 to 40 sailboats of this kind engaged in taking cunners, flounders, and herring in and near Boston Harbor; but in recent years the owners who continued fishing have changed to large vessels as their boats were worn out or lost.

Barnstable County had 2,251 persons employed in its fisheries. The number of vessels engaged in fishing and transporting was 124, valued at $223,225, having a net tonnage of 3,320 tons, and outfit valued at $91,729; the number of boats in the shore fisheries was 934, valued at $72,275; the apparatus of capture on vessels and boats was valued at $156,024; the shore and accessory property in the fisheries and wholesale fishery trade at $146,073; and the cash capital was $29,500, the total investment being $718,826. The yield was 36,156,018 pounds, valued at $932,828.

Provincetown, which is the principal fishing port in this county, had 1,001 persons employed in its fisheries; of this number 673 were on vessels, 254 on boats, and 74 were shoresmen. There were 66 vessels in the food fisheries and 4 in the whale fisheries, a total of 70 vessels, valued at $169,425, the net tonnage of which was 2,814 tons and the value of their outfit $77,944. The vessels in the food fisheries included 3 small steamboats and 1 vessel propelled by gasoline. There were 9 vessels engaged in the cod fisheries on the Grand Banks of Newfoundland; 2 large vessels and 30 small ones varying from 5 to 20 tons each fished for mackerel; 20 of the larger vessels fished for cod and haddock on Georges, Browns, and other banks off the New England coast, and many small vessels and boats, during the summer months, took ground-fish, mackerel, and herring in the inshore waters. The number of boats in the shore fisheries, including 11 power boats using steam or gasoline, was 226, valued at $24,820. The apparatus of capture used on vessels consisted chiefly of hand and trawl lines to the value of $11,043; 1,308 gill nets, $10,626, and

20 beam trawls, \$1,390. In the shore fisheries there were 16 pound nets, \$28,300; hand and trawl lines worth \$6,890; 30 beam trawls, \$1,800; 288 gill nets, \$2,304, and 318 lobster pots, \$218. The gill nets used in the vessel fisheries are drift nets, and are known locally as "drag gill nets." They average about 242 feet in length, 80 meshes or 20 feet in depth, and the size of the mesh is 3⅛ to 3½ inches stretched. They were first used in the mackerel fishery of Massachusetts in June, 1845, by Capt. N. E. Atwood, who fished them in Provincetown Harbor. When operated, a number of the nets are fastened together, making a continuous net a half mile to a mile in length, which is supported by buoys. The vessel, with the net attached, drifts with the tide, sails being used when necessary. These nets are usually fished at night, and are sunk deep enough below the surface of the water to avoid being damaged or destroyed by passing vessels. The catch taken with drift gill nets in 1902 was 619,100 pounds of mackerel and herring, valued at \$26,810. The investment in the fisheries and wholesale fishery trade of Provincetown was \$457,660. The products of the fisheries, which were marketed chiefly at Boston, amounted to 23,311,009 pounds, valued at \$529,244. Of this quantity 15,618,497 pounds, valued at \$433,075, was taken by vessels, and 7,692,512 pounds, valued at \$106,169, by boats in the shore fisheries. The larger vessels land their catch at Boston direct from the fishing grounds, and the products taken by small vessels and boats are shipped to Boston and New York on a fast fish train that leaves Provincetown daily.

The use of beam trawls in the flounder fishery at Provincetown and vicinity is also an interesting feature of the fisheries of Barnstable County. This apparatus is not used elsewhere in the United States in the commercial fisheries. The number of beam trawls in the entire county has increased since 1898 from 27, valued at \$1,610, to 65, valued at \$3,295, and the catch, consisting wholly of flounders, from 766,850 pounds, \$8,564, to 1,419,809 pounds, \$43,169. These nets cost about \$60 each. The beam is from 20 to 30 feet long, the net or bag 75 feet long, and the size of mesh 3¼ inches stretched. The flounders taken average about a pound in weight. They continue to be plentiful on the sandy bottoms of Provincetown Harbor and Cape Cod Bay.

Bristol County was third in importance in the extent of its fisheries. The number of persons employed was 1,262, the investment was \$603,701, and the products amounted to 6,289,554 pounds, valued at \$446,329. The number of vessels was 34, valued at \$137,850; their net tonnage was 4,104 tons, and the value of their outfit \$205,060. The number of boats in the shore fisheries was 355, valued at \$13,675; the fishing apparatus on vessels and boats was valued at \$6,175; the shore property at \$98,441, and the cash capital was \$142,500.

The whale fleet of New Bedford in 1902 numbered 21 vessels of

3,802 net tons, valued with their outfit at $320,900. The number of men engaged was 606, and the products, consisting of oil and whalebone, were valued at $330,787.

In Plymouth, Dukes, Nantucket, and Norfolk counties the aggregate number of persons employed in the fisheries was 1,262, the investment $317,920, and the products 12,859,591 pounds, valued at $521,464.

The following tables give the extent of the fisheries in each county of Massachusetts in 1902:

Table showing by counties the number of persons employed in the fisheries of Massachusetts in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore, or boat fisheries.	Shoresmen.	Total.
Barnstable	821	4	1,286	140	2,251
Bristol	688	4	402	168	1,262
Dukes	21	1	225	26	273
Essex	4,614	16	943	1,533	7,106
Nantucket			219	128	347
Norfolk			38		38
Plymouth	176		428		604
Suffolk	1,226	7	268	918	2,419
Total	7,546	32	3,809	2,913	14,300

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Massachusetts in 1902.

Items.	Barnstable.		Bristol.		Dukes.		Essex.		Nantucket.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	122	$221,825	32	$136,850	8	$4,850	328	$1,499,826	12	$11,500
Tonnage	3,273		4,064		69		19,305		84	
Outfit		91,579		204,965		1,218		692,867		1,387
Vessels transporting	2	1,400	2	1,000	1	1,500	4	8,100		
Tonnage	47		40		6		273			
Outfit		150		95		210		730		
Boats	934	72,275	355	13,675	197	29,515	585	55,070	105	9,170
Apparatus—vessel fisheries:										
Seines	11	4,900					143	99,875	4	525
Gill nets	1,435	12,003	136	1,239	159	1,373	4,273	40,679	164	2,140
Pound nets									1	300
Lines, hand and trawl		11,161		555		90		99,264		134
Beam trawls	20	1,390								
Harpoons, sword-fish		45		68		24		935		
Pots, lobster	340	417					285	427		
Dredges	12	72			10	30			62	124
Rakes	6	42								
Minor apparatus								12		8
Apparatus—shore fisheries:										
Seines	15	632	19	1,350	4	320	30	6,450	6	30
Gill nets	686	6,557					1,390	11,570	120	1,500
Pound nets and trap nets	99	102,175			50	29,875	16	12,900		
Lines, hand and trawl		7,050		74		79		3,995		97
Dip nets	83	143			4	8	53	108		
Beam trawls	45	1,905								
Fyke nets	18	156								
Pots, lobster	1,890	2,037	565	649	1,645	2,047	6,503	8,656	555	828
Pots, eel	469	461			450	600	75	150		
Cunner nets and traps								54		
Spears, eel	58	104			12	18			28	35
Weirs, eel	28	725								
Harpoons, sword-fish						6		50		
Dredges	399	843	137	470	160	480			340	680
Tongs, rakes, forks, and hoes	629	3,160	287	1,750	120	540	350	176	20	80
Minor apparatus		46		20						
Shore and accessory property		146,073		98,441		3,241		1,472,869		800
Cash capital		29,500		142,500		5,000		1,304,500		1,000
Total		718,826		603,701		81,024		5,319,263		30,338

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Massachusetts in 1902—Continued.

Items.	Norfolk.		Plymouth.		Suffolk.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			14	$91,150	78	$574,450	591	$2,543,451
Tonnage			616		4,551		31,965	
Outfit				46,775		321,552		1,360,323
Vessels transporting					2	6,900	11	18,900
Tonnage					39		405	
Outfit						1,200		2,385
Boats	37	$3,970	301	21,208	174	9,080	2,688	213,963
Apparatus—vessel fisheries:								
Seines			2	1,800	18	14,400	178	121,500
Gill nets			300	3,250	388	3,800	6,855	64,484
Pound nets							1	300
Lines, hand and trawl				7,020		52,085		170,309
Beam trawls							20	1,390
Harpoons, sword-fish				165		1,560		2,797
Pots, lobster					200	150	825	994
Dredges							84	226
Rakes							6	42
Minor apparatus								20
Apparatus—shore fisheries:								
Seines			1	17			75	8,799
Gill nets			20	200			2,216	19,827
Poundnets and trapnets					4	5,500	169	150,450
Lines, hand and trawl				65		1,210		12,570
Dip nets			15	31			155	290
Beam trawls							45	1,905
Fyke nets							18	156
Pots, lobster	2,145	3,157	8,098	12,454	4,150	5,186	25,551	35,014
Pots, eel							994	1,211
Cunner nets and traps								54
Spears, eel							98	157
Weirs, eel							28	725
Harpoons, sword-fish								56
Dredges							1,036	2,473
Tongs, rakes, forks, and hoes			89	498	40	34	1,535	6,238
Rakes, Irish moss	10	50	130	523			140	573
Minor apparatus		45				27		138
Shore and accessory property		1,100		10,100		1,749,750		3,482,374
Cash capital						1,105,000		2,587,500
Total		8,322		198,236		3,851,884		10,811,594

Table showing by counties the products of the fisheries of Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Dukes.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	738,850	$5,749	110,792	$1,295	279,508	$5,956
Alewives, salted	1,245,000	15,934	373,000	4,604	51,000	594
Alewives, smoked	114,000	1,140				
Blue-fish	67,300	5,732			10,200	716
Bonito	11,200	437			123,000	4,186
Butter-fish	70,000	2,850			29,800	1,319
Cod, fresh	6,179,967	177,105	76,000	2,160	47,000	1,030
Cod, salted	1,531,490	53,524	239,000	7,170	22,500	1,200
Cusk, fresh	362,316	5,099				
Eels	284,044	14,442			36,000	1,472
Flounders	1,815,517	53,794	21,000	420	172,900	3,412
Haddock, fresh	4,996,930	108,952	18,000	570	1,500	75
Haddock, salted	16,800	338				
Hake, fresh	673,424	8,619				
Hake, salted			34,000	340		
Halibut, fresh	119,780	11,928				
Herring, fresh	3,656,500	36,507				
Hickory shad	1,650	25				
Horse mackerel	69,095	1,798				
Mackerel, fresh	1,529,200	74,112	115,800	5,844	179,900	8,495
Mackerel, salted	161,000	10,060				
Menhaden	548,000	3,247				
Perch, white			5,000	500	1,300	130
Pollock, fresh	1,994,637	19,126				
Pollock, salted	154,560	3,072	20,000	200		
Sand eels	120,000	2,000				
Scup	28,400	898	30,000	870	489,000	11,965

Table showing by counties the products of the fisheries of Massachusetts in 1902—Cont'd.

Species.	Barnstable.		Bristol.		Dukes.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Sea bass	13,200	$620	3,000	$210	79,800	$4,939
Shad	1,280	76	13,932	757	1,200	60
Squeteague	1,453,617	26,527	38,000	1,440	2,247,500	61,295
Striped bass	25,009	2,430	2,500	150	400	40
Sturgeon	6,535	372				
Sword-fish	23,257	2,237	34,200	2,212	8,108	488
Tautog	52,585	1,434	86,000	2,755	43,500	1,277
Tomcod	2,000	40	30,000	450		
Whiting or silver hake	861,200	2,360				
Lobsters	94,229	9,568	16,100	1,935	56,125	6,005
Shrimp	6,000	1,500				
Squid	5,355,476	25,241			9,600	99
Clams, hard	204,544	30,224	431,200	67,125	120,000	18,750
Clams, soft	26,940	2,426	5,000	625	3,000	300
Oysters, market	483,602	111,252	45,500	9,000		
Oysters, seed	180,600	12,430	14,000	1,000		
Scallops	182,250	33,505	19,200	4,000	80,400	22,340
Oil, whale	647,427	52,088	4,489,330	240,787		
Oil, cod	42,847	1,860				
Oil, dog-fish	3,750	150				
Whalebone			19,000	90,000		
Total	36,156,018	932,828	6,289,554	446,329	4,093,241	156,143

Species.	Essex.		Nantucket.		Norfolk.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	57,200	$589				
Blue-fish			113,100	$8,954		
Bonito			32,270	1,291		
Butter-fish	4,450	155	1,800	72		
Cat-fish	2,500	50				
Cod, fresh	24,420,822	538,898				
Cod, salted	26,772,928	721,503	214,500	10,700		
Cusk, fresh	1,904,870	28,527				
Cusk, salted	155,721	2,573				
Cunners	52,550	2,394			30,000	$1,500
Eels	100,000	4,000	16,000	800		
Flounders	25,050	476	8,000	240		
Haddock, fresh	14,440,977	262,637	37,000	1,202		
Haddock, salted	574,273	8,246				
Hake, fresh	7,347,817	79,814				
Hake, salted	443,813	5,911				
Halibut, fresh	5,154,926	313,456				
Halibut, salted	936,128	54,239				
Herring, fresh	12,586,403	184,046				
Herring, salted	11,153,698	152,778				
Horse mackerel	6,000	240	560	17		
Mackerel, fresh	6,521,369	324,102	92,500	3,700		
Mackerel, salted	6,777,222	423,809				
Menhaden	277,000	1,637				
Pollock, fresh	7,733,846	65,957	63,000	1,890		
Pollock, salted	1,087,913	11,938				
Scup			19,000	570		
Shad	4,835	244				
Squeteague	12,500	420	13,000	390		
Sword-fish	303,661	24,375				
Tautog	2,200	101				
Whiting or silver hake	1,215,000	3,950				
Lobsters	534,159	58,890	16,750	2,075	109,062	11,700
Clams, hard			26,800	5,085		
Clams, soft	2,072,200	142,048				
Scallops			115,050	30,137		
Irish moss					60,000	2,700
Oil, cod	129,806	5,715				
Halibut fins	34,400	1,644				
Tongues and sounds	11,566	433				
Cod roe	16,700	531				
Total	132,874,503	3,426,326	769,330	67,123	199,062	15,900

Table showing by counties the products of the fisheries of Massachusetts in 1902—Cont'd.

Species.	Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives, fresh	134,000	$1,631	....	....	1,320,350	$15,220
Alewives, salted	310,000	3,487	....	....	1,979,000	24,619
Alewives, smoked	....	....	....	....	114,000	1,140
Blue-fish	4,250	340	....	....	194,850	15,742
Bonito	....	....	....	....	166,470	5,914
Butter-fish	....	....	....	....	106,050	4,396
Cat-fish	....	....	....	....	2,500	50
Cod, fresh	1,702,900	40,750	8,232,303	$216,276	40,658,992	976,219
Cod, salted	33,575	1,250	48,400	1,376	28,862,393	796,723
Cusk, fresh	39,500	765	430,900	8,546	2,737,586	42,937
Cusk, salted	....	....	....	....	155,721	2,573
Cunners	....	....	57,600	3,840	140,150	7,734
Dog-fish	52,800	200	....	....	52,800	200
Eels	....	....	57,600	4,608	493,644	25,322
Flounders	....	....	553,200	22,064	2,595,667	80,406
Haddock, fresh	2,082,100	46,428	17,051,950	373,420	38,628,457	793,284
Haddock, salted	....	....	....	....	591,073	8,584
Hake, fresh	708,300	11,206	5,150,600	85,489	13,880,141	185,128
Hake, salted	....	....	....	....	477,813	6,251
Halibut, fresh	629,000	46,850	5,076,100	206,270	10,979,806	578,504
Halibut, salted	40,000	2,400	200,000	13,500	1,176,128	70,139
Herring, fresh	16,000	150	721,000	10,350	16,982,903	231,053
Herring, salted	....	....	1,098,600	17,200	12,252,298	169,978
Hickory shad	....	....	....	....	1,650	25
Horse mackerel	....	....	....	....	75,655	2,055
Mackerel, fresh	438,100	22,468	1,103,631	56,873	9,980,500	495,594
Mackerel, salted	....	....	705,600	51,522	7,643,822	485,391
Menhaden	....	....	50,000	525	875,000	5,409
Perch, white	....	....	....	....	6,300	630
Pollock, fresh	225,200	2,509	896,500	13,076	10,913,183	102,558
Pollock, salted	....	....	....	....	1,262,473	15,210
Sand eels	....	....	....	....	120,000	2,000
Scup	22,500	675	....	....	588,900	14,978
Sea bass	....	....	....	....	96,000	5,679
Shad	....	....	....	....	21,247	1,137
Squeteague	....	....	5,600	180	3,770,217	90,252
Striped bass	....	....	....	....	27,909	2,620
Sturgeon	....	....	....	....	6,535	372
Sword-fish	98,800	7,904	282,100	20,539	750,126	57,746
Tautog	29,000	870	....	....	213,285	6,437
Tomcod	....	....	....	....	32,000	490
Whiting or silver hake	....	....	210,000	1,575	2,286,200	7,885
Lobsters	473,183	44,960	391,080	39,962	1,695,688	175,095
Shrimp	....	....	....	....	6,000	1,500
Squid	....	....	....	....	5,365,076	25,340
Clams, hard	72,000	9,955	....	....	854,544	131,139
Clams, soft	31,750	3,550	140,520	8,298	2,279,410	157,247
Oysters, market	....	....	....	....	529,102	120,252
Oysters, seed	....	....	....	....	194,600	13,430
Scallops	....	....	....	....	396,900	89,982
Cockles	20,000	5,600	....	....	20,000	5,600
Irish moss	630,000	28,350	....	....	690,000	31,050
Oil, whale	....	....	....	....	5,136,767	292,875
Oil, cod	....	....	....	....	172,653	7,575
Oil, dog-fish	....	....	....	....	3,750	150
Whalebone	....	....	....	....	19,000	90,000
Halibut fins	....	....	....	....	34,400	1,644
Tongues and sounds	....	....	....	....	11,566	433
Cod roe	....	....	....	....	16,700	531
Total	7,797,958	282,298	42,466,284	1,155,480	230,645,950	6,482,427

THE PRODUCTS BY APPARATUS.

The principal forms of apparatus of capture employed in the fisheries of Massachusetts in 1902 were seines, gill nets, pound nets and trap nets, fyke nets, dip nets, beam trawls, hand and trawl lines, lobster and eel pots, dredges, tongs and rakes, and harpoons and other appliances for taking sword-fish and whales.

Hand and trawl lines were the most important apparatus, considering the quantity and value of products secured, the catch being 149,044,508

pounds, valued at $3,607,949, of which 141,871,580 pounds, worth $3,423,426, were caught by vessels and 7,172,928 pounds, worth $184,-523, by boats in the shore fisheries. The more important species were cod, 67,647,095 pounds, $1,729,309; haddock, 39,215,730 pounds, $801,792; hake, 14,349,954 pounds, $191,279; pollock, 10,579,219 pounds, $104,824; cusk, 2,893,307 pounds, $45,510; flounders, 885,350 pounds, $30,362; tautog, 197,500 pounds, $6,120, and halibut, 12,155,-934 pounds, $648,643. A number of other species—blue-fish, mackerel, cat-fish, cunners, dog-fish, eels, scup, sea bass, squeteague, striped bass, and whiting or silver hake—were taken in smaller quantities. The secondary products, such as oil, roe, and sounds or swim-bladders from fish taken by lines, amounted to 204,669 pounds, for which the fishermen received $8,689.

The seine catch, which was next in value, was 21,316,747 pounds, valued at $879,412. The species taken were mackerel, 13,954,853 pounds, $804,529; herring, 3,841,866 pounds, $30,878; alewives, 1,749,-450 pounds, $21,445; pollock, 965,612 pounds, $4,828; menhaden, 430,000 pounds, $2,950; sand eels, 120,000 pounds, $2,000; cod, 88,750 pounds, $1,855; blue-fish, 85,625 pounds, $6,850; tomcod, 30,000 pounds, $450; squeteague, 14,500 pounds, $145; eels, 8,400 pounds, $420; shad, 13,932 pounds, $757; striped bass, 1,459 pounds, $175, and shrimp, 6,000 pounds, $1,500.

Gill nets took 24,397,978 pounds of fish, valued at $497,378. The greater part of this quantity, or 19,814,835 pounds, valued at $318,354, was herring, of which 18,469,335 pounds, valued at $305,909, were from off the coast of Newfoundland, and 1,345,500 pounds, valued at $12,445, were taken in the boat or shore fisheries. The remaining species secured in gill nets were mackerel, 2,856,219 pounds, $134,844; cod, 1,622,414 pounds, $37,664; blue-fish, 65,375 pounds, $5,034; bonito, 26,135 pounds, $1,046; squeteague, 5,000 pounds, $150; haddock, 3,800 pounds, $76, and shad, 4,200 pounds, $210.

Gill nets were first used in the cod fisheries of this country in 1878, being introduced from Norway by Prof. Spencer F. Baird, then Commissioner of Fisheries. For a number of years they were used quite extensively in Ipswich Bay, but, shore cod becoming scarce, their use was practically discontinued. Within the past few years cod have been more abundant and gill nets have again been employed successfully in this fishery. In the meantime the waters of this section have been restocked each year with young cod from the government fish hatchery at Gloucester.

Pound nets and trap nets secured 19,234,567 pounds of products, valued at $241,220. The species taken in largest quantities were herring, 4,862,500 pounds, $46,219; squeteague, 3,712,717 pounds, $88,-517; whiting or silver hake, 2,256,200 pounds, $7,585; pollock, 630,825 pounds, $8,116; scup, 476,200 pounds, $11,823; menhaden,

445,000 pounds, $2,459; mackerel, 315,250 pounds, $16,618, and squid, 5,365,076 pounds, $25,340. The remaining species, aggregating 1,170,-799 pounds, valued at $34,543, were bonito, butter-fish, flounders, alewives, blue-fish, cod, cunners, eels, hake, hickory shad, sea bass, striped bass, sturgeon, tautog, tomcod, shad, and horse mackerel.

The catch with dredges, tongs, rakes, etc., comprised oysters, 103,-386 bushels, $133,682; hard clams, 106,518 bushels, $130,839; soft clams, 227,941 bushels, $157,247; scallops, 65,925 bushels, $89,832, and cockles, 2,000 bushels, $5,600.

The oysters were taken chiefly with tongs, the clams with rakes, hoes, etc., the scallops with dredges, and the cockles were mostly picked up by hand. At Wellfleet rakes which have been recently introduced are used quite extensively in taking hard clams. These rakes have an iron frame 26 inches long and 8 inches wide, and from 18 to 21 teeth 4½ inches long. A bag of wire netting 3 feet long is attached to the frame to catch the clams as they are raked from the bottom. The handle is a strong ash or oak pole from 20 to 40 feet long, according to the depth of water in which the rake is to be used, and weighs from 8 to 12 pounds. The cost of the apparatus is $7.

Lobster pots, which are the only apparatus employed in the lobster fishery, took 1,695,688 pounds of lobsters, the value of which was $175,095; dip nets secured 1,428,000 pounds of alewives, $17,001, and 680,000 pounds of herring, $5,100; fyke nets, 16,725 pounds of eels, $1,014, and 6,000 pounds of flounders, $180; eel weirs, 49,687 pounds of eels, $1,950; cunner nets and pots, eel pots, and spears, 23,500 pounds of cunners, $1,410; eels, 326,332 pounds, $15,866, and flounders, 4,300 pounds, $150; beam trawls, used in Barnstable County but not elsewhere in the United States in the commercial fisheries, 1,419,809 pounds of flounders, $43,169, and minor forms of apparatus, 135,410 pounds of several different species, valued at $6,662. The catch of sword-fish with harpoons in the vessel and shore fisheries was 750,126 pounds, worth $57,746. The products taken with harpoons, bomb guns, lances, etc., in the whale fisheries, including the catch by vessels from New Bedford, Mass., which sail from San Francisco, Cal., consisted of 684,902 gallons of whale and sperm oil, $292,875, and 19,000 pounds of whalebone, $90,000.

The following tables show by counties and species the quantity and value of products taken with the various forms of fishing apparatus in the vessel and shore fisheries of Massachusetts in 1902.

Table showing by counties the yield of the seine fisheries of Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Dukes.		Essex.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Cod	8,000	$240					25,000	$500
Herring, fresh							1,540,000	16,143
Herring, salted							106,866	548
Mackerel, fresh	276,800	15,318					4,960,240	249,450
Mackerel, salted	161,000	10,060					6,741,522	421,293
Menhaden	360,000	2,250					70,000	700
Pollock	450,612	2,253					150,000	750
Sand eels	120,000	2,000						
Squeteague	14,500	145						
Striped bass	1,459	175						
Total	1,392,371	32,441					13,593,628	689,384
Shore fisheries:								
Alewives, fresh	300,000	1,800	110,792	$1,295	254,258	$5,644		
Alewives, salted	586,400	6,696	373,000	4,604	35,000	394		
Cod							55,750	1,115
Eels					2,400	120		
Herring							2,195,000	14,187
Mackerel							5,500	275
Perch, white			5,000	500	1,300	130		
Pollock							365,000	1,825
Shad			13,932	757				
Tomcod			30,000	450				
Shrimp	6,000	1,500						
Total	892,400	9,996	532,724	7,606	292,958	6,288	2,621,250	17,402
Grand total	2,284,771	42,437	532,724	7,606	292,958	6,288	16,214,878	706,786

Species.	Nantucket.		Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish	85,625	$6,850					85,625	$6,850
Cod							33,000	740
Herring, fresh							1,540,000	16,143
Herring, salted							106,866	548
Mackerel, fresh			146,500	$7,868	957,691	$48,743	6,341,231	321,379
Mackerel, salted					705,600	51,522	7,608,122	482,875
Menhaden							430,000	2,950
Pollock							600,612	3,003
Sand eels							120,000	2,000
Squeteague							14,500	145
Striped bass							1,459	175
Total	85,625	6,850	146,500	7,868	1,663,291	100,265	16,881,415	836,808
Shore fisheries:								
Alewives, fresh							665,050	8,739
Alewives, salted			90,000	1,012			1,084,400	12,706
Cod							55,750	1,115
Eels	6,000	300					8,400	420
Herring							2,195,000	14,187
Mackerel							5,500	275
Perch, white							6,300	630
Pollock							365,000	1,825
Shad							13,932	757
Tomcod							30,000	450
Shrimp							6,000	1,500
Total	6,000	300	90,000	1,012			4,435,332	42,604
Grand total	91,625	7,150	236,500	8,880	1,663,291	100,265	21,316,747	879,412

Table showing by counties the yield of the gill-net fisheries of Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Dukes.		Essex.	
	Lbs.	Value.	Lbs.	Value	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish	21,500	$1,670						
Cod	33,334	1,000					1,589,080	$36,664
Haddock							3,800	76
Herring, fresh							6,039,903	129,479
Herring, salted							11,046,832	152,230
Mackerel, fresh	642,100	27,870	60,000	$3,030	93,000	$1,230	1,385,940	65,116
Mackerel, salted							35,700	2,516
Shad							4,200	210
Total	696,934	30,540	60,000	3,030	93,000	4,230	20,105,455	386,291
Shore fisheries:								
Blue-fish	17,500	1,348						
Herring	92,000	920					1,237,500	11,375
Mackerel	77,100	4,335					83,839	4,192
Total	186,600	6,603					1,321,339	15,567
Grand total	883,534	37,143	60,000	3,030	93,000	4,230	21,426,794	401,858

Species.	Nantucket.		Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish	10,375	$736					31,875	$2,406
Bonito	26,135	1,046					26,135	1,046
Cod							1,622,414	37,664
Haddock							3,800	76
Herring, fresh					284,000	$7,000	6,323,903	136,479
Herring' salted					1,098,600	17,200	12,145,432	169,430
Mackerel, fresh	90,500	3,620	268,500	$13,425	115,940	6,330	2,655,980	123,621
Mackerel, salted							35,700	2,516
Shad							4,200	210
Total	127,010	5,402	268,500	13,425	1,498,540	30,530	22,849,439	473,448
Shore fisheries:								
Blue-fish	16,000	1,280					33,500	2,628
Herring			16,000	150			1,315,500	12,415
Mackerel	2,000	80	1,600	100			164,539	8,707
Squeteaguè	5,000	150					5,000	150
Total	23,000	1,510	17,600	250			1,548,539	23,930
Grand total	150,010	6,912	286,100	13,675	1,498,540	30,530	24,397,978	497,378

Table showing by counties the yield of the pound-net and trap-net fisheries of Massachusetts in 1902.

Species.	Barnstable.		Dukes.		Essex.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:						
Alewives, fresh	121,250	$1,215	25,250	$312	57,200	$589
Alewives, salted	32,200	417				
Blue-fish	26,000	2,529	200	16		
Bonito	11,200	437	123,000	4,186		
Butter-fish	70,000	2,850	29,800	1,319	4,450	155
Cod, fresh	86,336	2,193			58,300	1,414
Cod, salted	2,850	116				
Cunners					25,300	759
Eels	27,000	1,080	400	9		
Flounders	160,208	4,230	108,900	2,132	5,900	59
Hake					8,000	100
Herring	3,564,500	35,587			858,000	7,282
Hickory shad	1,650	25				
Horse mackerel	69,095	1,798			6,000	240
Mackerel	159,700	7,694	40,900	2,115	84,650	5,009
Menhaden	188,000	997			207,000	937
Pollock	478,825	5,066			89,000	1,160
Scup	14,400	485	455,800	11,155		

Table showing by counties the yield of the pound-net and trap-net fisheries of Massachusetts in 1902—Continued.

Species.	Barnstable.		Dukes.		Essex.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries—Continued.						
Sea bass			34,400	$2,612		
Shad	1,280	$76	1,200	60	635	$34
Squeteague	1,439,117	26,382	2,247,500	61,295	12,500	420
Striped bass	19,300	1,980	400	40		
Sturgeon	6,535	372				
Tautog	12,085	179	1,500	37	2,200	101
Tomcod	2,000	40				
Whiting	861,200	2,360			1,215,000	3,950
Squid	5,355,476	25,241	9,600	99		
Total	12,710,207	123,352	3,078,850	85,387	2,634,135	22,209
Grand total	12,710,207	123,352	3,078,850	85,387	2,634,135	22,209

Species.	Nantucket.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Bonito	6,135	$245			6,135	$245
Butter-fish	1,800	72			1,800	72
Flounders	2,000	60			2,000	60
Pollock	63,000	1,890			63,000	1,890
Scup	6,000	180			6,000	180
Squeteague	8,000	240			8,000	240
Total	86,935	2,687			86,935	2,687
Shore fisheries:						
Alewives, fresh					203,700	2,116
Alewives, salted					32,200	417
Blue-fish					26,200	2,545
Bonito					134,200	4,623
Butter-fish					104,250	4,324
Cod, fresh			15,640	$391	160,276	3,998
Cod, salted					2,850	116
Cunners					25,300	759
Eels					27,400	1,089
Flounders			3,200	64	278,208	6,485
Hake					8,000	100
Herring			440,000	3,350	4,862,500	46,219
Hickory shad					1,650	25
Horse mackerel					75,095	2,038
Mackerel			30,000	1,800	315,250	16,618
Menhaden			50,000	525	445,000	2,459
Pollock					567,825	6,226
Scup					470,200	11,643
Sea bass					34,400	2,612
Shad					3,115	170
Squeteague			5,600	180	3,704,717	88,277
Striped bass					19,700	2,020
Sturgeon					6,535	372
Tautog					15,785	317
Tomcod					2,000	40
Whiting			180,000	1,275	2,256,200	7,585
Squid					5,365,076	25,340
Total			724,440	7,585	19,147,632	238,533
Grand total	86,935	2,687	724,440	7,585	19,234,567	241,220

Table showing by counties the catch by dip nets, fyke nets, and eel weirs in Massachusetts in 1902.

Species.	Barnstable.		Dukes.		Essex.		Plymouth.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Dip nets—										
Alewives, fresh	317,600	$2,734					134,000	$1,631	451,600	$4,365
Alewives, salted	626,400	8,821	16,000	$200			220,000	2,475	862,400	11,496
Alewives, smoked	114,000	1,140							114,000	1,140
Herring					680,000	$5,100			680,000	5,100
Total	1,058,000	12,695	16,000	200	680,000	5,100	354,000	4,106	2,108,000	22,101
Fyke nets—										
Eels	16,725	1,014							16,725	1,014
Flounders	6,000	180							6,000	180
Total	22,725	1,194							22,725	1,194
Eel weirs—										
Eels	49,687	1,950							49,687	1,950
Grand total	1,130,412	15,839	16,000	200	680,000	5,100	354,000	4,106	2,180,412	25,245

Table showing by counties the catch by minor apparatus in Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Essex.		Nantucket.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Herring, fresh					36,000	$480		
Horse mackerel							560	$17
Clams, hard							2,400	300
Total					36,000	480	2,960	317
Shore fisheries:								
Eels			7,500	$375				
Scallops	1,350	$150						
Total	1,350	150	7,500	375				
Grand total	1,350	150	7,500	375	36,000	480	2,960	317

Species.	Norfolk.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Herring, fresh					36,000	$480
Horse mackerel					560	17
Clams, hard					2,400	300
Total					38,960	797
Shore fisheries:						
Cunners	30,000	$1,500	57,600	$3,840	87,600	5,340
Eels					7,500	375
Scallops					1,350	150
Total	30,000	1,500	57,600	3,840	96,450	5,865
Grand total	30,000	1,500	57,600	3,840	135,410	6,662

Table showing by counties the yield of the hand and trawl line fisheries of Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Dukes.		Essex.	
	Lbs.	Value.	Lbs.	Value	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish	300	$25						
Cod, fresh	4,854,397	137,830	72,000	$2,040	17,000	$405	21,130,138	$460,896
Cod, salted	1,510,640	52,658	239,000	7,170			26,772,928	721,503
Cusk, fresh	362,316	5,099					1,904,870	28,527
Cusk, salted							155,721	2,573
Flounders	3,000	80	12,000	240	4,000	80	6,500	130
Haddock, fresh	4,200,930	92,802	18,000	570	1,500	75	14,210,952	257,086
Haddock, salted	16,800	338					574,273	8,246
Hake, fresh	548,424	6,744					7,280,017	79,055
Hake, salted			34,000	340			443,813	5,911
Halibut, fresh	119,780	11,928					5,151,926	313,456
Halibut, salted							936,128	54,239
Mackerel	332,500	16,845	55,000	2,750	13,500	600	1,200	60
Pollock, fresh	812,700	8,032					6,203,522	53,900
Pollock, salted	154,560	3,072	20,000	200			1,087,913	11,938
Scup	7,000	200	3,000	105	17,000	375		
Sea bass	6,800	300	3,000	120	18,000	1,060		
Tautog	19,000	610						
Halibut fins							34,400	1,644
Cod roe							16,700	531
Cod oil	42,847	1,860					129,806	5,715
Tongues and sounds							11,566	433
Total	12,991 994	338,423	456,000	13,535	71,000	2,595	86,055,373	2,005,843
Shore fisheries:								
Blue-fish	2,000	160			10,000	700		
Cat-fish							2,500	50
Cod, fresh	1,197,900	35,842	4,000	120	30,000	625	1,562,554	38,309
Cod, salted	18,000	750			22,500	1,200		
Cunners							3,750	225
Flounders	225,500	6,085	9,000	180	60,000	1,200	9,350	187
Haddock	796,000	16,150					226,225	5,475
Hake	125,000	1,875					59,800	659
Mackerel	41,000	2,050	800	64	32,500	1,550		
Pollock	252,500	3,775					926,324	8,322
Scup	7,000	210	27,000	765	16,200	435		
Sea bass	6,400	320			27,400	1,267		
Squeteague			38,000	1,440				
Striped bass	4,250	275	2,500	150				
Tautog	21,500	645	86,000	2,755	42,000	1,240		
Dog-fish oil	3,750	150						
Total	2,700,800	68,287	167,300	5,474	240,600	8,217	2,790,503	53,227
Grand total	15,692,794	406,710	623,300	19,009	311,600	10,812	88,845,876	2,059,070

Species.	Nantucket.		Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish	1,100	$88	500	$40			1,900	$153
Cod, fresh			1,614,900	38,450	8,116,663	$211,885	35,805,098	851,506
Cod, salted	32,000	1,575	15,000	450	48,400	1,376	28,617,968	784,732
Cusk, fresh			39,500	765	430,900	8,546	2,737,586	42,937
Cusk, salted							155,721	2,573
Flounders							25,500	530
Haddock, fresh	18,500	647	2,050,100	45,828	17,006,950	372,070	37,506,932	769,078
Haddock, salted							591,073	8,584
Hake, fresh			708,300	11,206	5,150,600	85,489	13,687,341	182,494
Hake, salted							477,813	6,251
Halibut, fresh			629,000	46,850	5,076,100	206,270	10,979,806	578,504
Halibut, salted			40,000	2,400	200,000	13,500	1,176,128	70,139
Mackerel			5,000	250			407,200	20,505
Pollock, fresh			225,200	2,509	881,500	12,626	8,122,922	77,067
Pollock, salted							1,262,473	15,210
Scup			3,500	105			30,500	785
Sea bass							27,800	1,480
Tautog			3,500	105			22,500	715
Halibut fins							34,400	1,644
Cod, roe							16,700	531
Cod, oil							172,653	7,575
Tongues and sounds							11,566	433
Total	51,600	2.310	5,334,500	148,958	36,911,113	911,762	111,871,580	3,423,426

Table showing by counties the yield of the hand and trawl line fisheries of Massachusetts in 1902—Continued.

Species	Nantucket.		Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Blue-fish			3,750	$200			15,750	$1,160
Cat-fish							2,500	50
Cod fresh			88,000	2,300	100,000	$4,000	2,982,454	81,196
Cod salted	182,500	$9,125	18,575	800			241,575	11,875
Cunners							3,750	225
Dog-fish			52,800	200			52,800	200
Eels					57,600	4,608	57,600	4,608
Flounders	6,000	180			550,000	22,000	859,850	29,832
Haddock	18,500	555	32,000	600	45,000	1,350	1,117,725	24,130
Hake							184,800	2,531
Mackerel			16,500	825			90,800	4,489
Pollock					15,000	450	1,193,824	12,547
Scup	13,000	390	19,000	570			82,200	2,370
Sea bass							33,800	1,587
Squeteague							38,000	1,440
Striped bass							6,750	425
Tautog			25,500	765			175,000	5,405
Whiting					30,000	300	30,000	300
Dog-fish oil							3,750	150
Total	220,000	10,250	256,125	6,360	797,600	32,708	7,172,928	181,523
Grand total	271,600	12,560	5,590,625	155,318	37,708,713	944,470	119,041,508	3,607,949

Table showing the catch by beam trawls in Barnstable County in 1902.

Fisheries.	Flounders.	
	Lbs.	Value.
Vessel	769,809	$23,669
Shore	650,000	19,500
Total	1,419,809	43,169

Table showing by counties the catch by lobster pots in Massachusetts in 1902.

Counties.	Lobsters.				Total.	
	Vessel fisheries.		Shore fisheries.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Barnstable	14,750	$1,615	79,479	$7,953	94,229	$9,568
Bristol			16,100	1,935	16,100	1,935
Dukes			56,125	6,095	56,125	6,005
Essex	18,571	2,000	515,588	56,890	534,159	58,890
Nantucket			16,750	2,075	16,750	2,075
Norfolk			109,062	11,700	109,062	11,700
Plymouth			478,183	44,960	478,183	44,960
Suffolk	35,000	3,500	356,080	36,462	391,080	39,962
Total	68,321	7,115	1,627,367	167,980	1,695,688	175,095

Table showing by counties the catch by cunner nets and pots and eel pots and spears in Massachusetts in 1902.

Species.	Barnstable.		Dukes.		Essex.		Nantucket.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Cunners					23,500	$1,410			23,500	$1,410
Eels	183,132	$10,023	33,200	$1,343	100,000	4,000	10,000	$500	326,332	15,866
Flounders	1,000	50			3,300	100			4,300	150
Total	184,132	10,073	33,200	1,343	126,800	5,510	10,000	500	354,132	17,426

Table showing by counties the catch by dredges, tongs, rakes, hoes, and forks in Massachusetts in 1902.

Species.	Barnstable.		Bristol.		Dukes.		Essex.		Nantucket.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Clams, hard....	9,496	$1,250	....	......	......	......	....	....	....	......
Oysters, market	38,500	7,332	....	......	......	......	....	....	....	......
Scallops........	900	150	....	......	2,400	$670	....	....	10,050	$3,887
Total.........	48,896	8,732	....	......	2,400	670	....	....	10,050	3,887
Shore fisheries:										
Clams, hard....	195,048	28,974	431,200	$67,125	120,000	18,750	....	....	24,400	4,785
Clams, soft.....	26,940	2,426	5,000	625	3,000	300	2,072,200	$142,048	....	......
Oysters, market	445,102	103,920	45,500	9,000	......	......	....	....	....	......
Oysters, seed...	180,600	12,430	14,000	1,000	......	......	....	....	....	......
Scallops........	180,000	33,205	19,200	4,000	78,000	21,670	....	....	105,000	26,250
Total.........	1,027,690	180,955	514,900	81,750	201,000	40,720	2,072,200	142,048	129,400	31,035
Grand total..	1,076,586	189,687	514,900	81,750	203,400	41,390	2,072,200	142,048	139,450	34,922

Species.	Norfolk.		Plymouth.		Suffolk.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Clams, hard....	....	....	....	....	....	....	9,496	$1,250
Oysters, market	....	....	....	....	....	....	38,500	7,332
Scallops........	....	....	....	....	....	....	13,350	4,707
Total.........	....	....	....	....	....	....	61,346	13,289
Shore fisheries:								
Clams, hard....	....	....	72,000	$9,955	....	....	842,648	129,589
Clams, soft.....	....	....	31,750	3,550	140,520	$8,298	2,279,410	157,247
Oysters, market	....	....	....	....	....	....	490,602	112,920
Oysters, seed...	....	....	....	....	....	....	194,600	13,430
Scallops........	....	....	....	....	....	....	382,200	85,125
Cockles	....	....	20,000	5,600	....	....	20,000	5,600
Irish moss......	60,000	$2,700	630,000	28,350	....	....	690,000	31,050
Total.........	60,000	2,700	753,750	47,455	140,520	8,298	4,899,460	534,961
Grand total..	60,000	2,700	753,750	47,455	140,520	8,298	4,960,806	548,250

Table showing by counties the products of the whale fisheries of Massachusetts in 1902.

Products.	Barnstable.		Bristol.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Oil, whale	647,437	$52,088	4,489,330	$240,787	5,136,767	$292,875
Whalebone	....	....	19,000	90,000	19,000	90,000
Total.........................	647,437	52,088	4,508,330	330,787	5,155,767	382,875

Table showing by counties the catch of sword-fish by harpoons in the vessel and shore fisheries of Massachusetts in 1902.

Counties.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Barnstable................................	23,257	$2,237	....	....	23,257	$2,237
Bristol	34,200	2,212	....	....	34,200	2,212
Dukes.....................................	4,108	288	4,000	$200	8,108	488
Essex	283,661	23,375	20,000	1,000	303,661	24,375
Plymouth..................................	98,800	7,904	....	....	98,800	7,904
Suffolk...................................	282,100	20,530	....	....	282,100	20,530
Total.................................	726,126	56,546	24,000	1,200	750,126	57,746

Table showing the persons and capital in the wholesale fishery trade of Boston in 1902.

Branches of trade.	Number of firms.	Number of persons engaged.	Shore property.	Wages paid.	Cash capital.
Fresh fish	41	373	$874,450	$231,580	$443,000
Salted, canned, and smoked fish	12	338	469,400	129,900	296,000
Oysters	8	91	157,600	48,800	153,000
Lobsters	12	75	164,250	36,800	155,000
Fish oil and glue	2	41	82,000	20,785	58,000
Total	75	918	1,747,700	467,865	1,105,000

Table showing the persons and capital in the wholesale fishery trade of Gloucester in 1902.

Branches of trade.	Number of firms.	Number of persons engaged.	Shore property.	Wages paid.	Cash capital.
Fresh fish	4	115	$138,700	$48,300	$136,000
Salted, smoked, and boneless fish	37	1,180	1,069,669	488,927	894,500
Oil, glue, and isinglass	10	238	253,100	76,018	274,000
Total	51	1,533	1,461,469	613,245	1,304,500

FISHERIES OF RHODE ISLAND.

The fisheries of Rhode Island in 1902 employed 2,117 persons, $1,014,280 worth of vessels, boats, apparatus of capture, shore property, etc., and yielded products to the value of $1,155,701.

These returns show an advance over those for 1898, when the number of persons employed was 1,687, the investment $957,142, and the value of the products amounted to $955,058.

The increase in the value of the yield has been due mainly to an enhanced value of the products per pound. The principal increase has occurred in scup, which in 1898 amounted to 6,390,225 pounds, worth $75,596, and in 1902 was 6,833,290 pounds, worth $160,854, an average of 1.18 cents per pound in the former year and of 2.35 in the latter. The yield of squeteague was nearly the same as in 1898, but the value per pound has increased from 2.04 to 2.40 cents.

The value of the mackerel catch has more than doubled, increasing from $15,000 to $32,950. The increase in the weight of the catch has been less, amounting to 359,900 pounds in 1898 and 615,600 pounds in 1902. Other species which have increased largely in yield are butter-fish, from 207,000 pounds to 362,910 pounds; haddock, from 366,525 pounds to 506,195 pounds, and sword-fish from 55,875 pounds to 126,900 pounds.

The yield of market oysters since 1898 has increased from 441,728 bushels to 516,479 bushels, and of seed oysters from 15,650 bushels to 91,550 bushels. In the same period the product of clams increased from 15,015 bushels to 26,490 bushels, and scallops from 19,231 to

19,942 bushels. In 1898 scallops averaged 54 cents per bushel, and in 1902 $1.26 per bushel.

The lobster fishery shows a great reduction, decreasing from 578,066 pounds in 1898 to 397,305 pounds in 1902, notwithstanding a slight increase in the number of pots used. The falling off in production has been almost counteracted by an increase in the price per pound, which averaged 7.50 cents in 1898 and 9.94 cents in 1902. Among the other species showing a decrease during this period are menhaden, from 3,140,000 pounds to 471,000 pounds; blue-fish, from 330,290 to 146,335 pounds; cod, from 1,426,912 to 690,160 pounds; striped bass, from 101,950 to 50,087 pounds; alewives, from 838,622 to 621,490 pounds, and flat-fish and flounders from 1,710,057 to 1,134,870 pounds.

The following series of tables shows the number of persons employed, the amount of capital invested, and the quantity and value of products in the fisheries of Rhode Island in 1902:

Persons employed.

How engaged.	No.
On vessels, fishing	394
On vessels, transporting	14
Boat or shore fishermen	1,017
Shoresmen	692
Total	2,117

Table of apparatus and capital.

Items.	Number.	Value.	Items.	Number.	Value.
Vessels fishing	79	$198,995	Apparatus—shore fisheries:		
Tonnage	1,239		Pound nets and trap nets.	160	71,590
Outfit		53,045	Seines	65	5,090
Vessels transporting	12	10,000	Gill nets	82	4,088
Tonnage	113		Fyke nets	701	4,216
Outfit		772	Lines, hand and trawl		579
Boats	1,130	103,841	Pots, lobster	10,204	11,232
Apparatus—vessel fisheries:			Pots, eel	3,750	2,668
Pound nets and trap nets.	38	54,200	Spears, eel	61	43
Purse seines	1	500	Dip nets	11	16
Gill nets	231	2,340	Dredges	1,208	4,048
Lines, hand and trawl		966	Rakes	67	228
Pots, lobster	330	390	Tongs	422	1,915
Pots, eel	220	220	Hoes	412	255
Harpoons		217	Shore and accessory property		359,235
Dredges	136	3,321	Cash capital		119,750
Tongs	110	520			
			Total		1,014,280

Table of products.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore or horse mackerel	1,200	$16			1,200	$16
Alewives, fresh	61,400	556	393,290	$4,711	454,690	5,267
Alewives, salted			166,800	2,099	166,800	2,099
Blue-fish	42,520	2,539	103,815	6,877	146,335	9,416
Bonito	1,100	88	124,080	3,772	125,180	3,860
Butter-fish	33,260	954	329,650	9,453	362,910	10,407
Cod	312,630	10,401	377,530	10,251	690,160	20,652

Table of products—Continued.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Eels	27,200	$1,360	424,540	$20,930	451,740	$22,290
Flat-fish and flounders	374,100	9,251	760,770	18,588	1,134,870	27,839
Haddock	428,295	12,034	77,900	2,231	506,195	14,265
Hickory shad	900	27	33,860	673	34,760	700
King-fish	2,030	168	1,400	196	3,430	364
Mackerel	265,490	16,077	350,110	16,873	615,600	32,950
Menhaden	30,000	176	441,000	980	471,000	1,156
Minnows			2,000	120	2,000	120
Perch			40,400	2,395	40,400	2,395
Pollock			30,000	300	30,000	300
Scup	5,372,250	114,572	1,461,040	46,282	6,833,290	160,854
Sea bass	99,120	5,560	148,100	7,458	247,220	13,018
Shad	2,600	182	28,186	2,283	30,786	2,465
Smelt			10,600	942	10,600	942
Spanish mackerel	220	32	190	32	410	64
Squeteague	635,640	15,597	2,522,475	60,256	3,158,115	75,853
Squid	24,700	585	69,150	1,946	93,850	2,531
Striped bass	30,510	2,557	19,577	2,360	50,087	4,917
Sword-fish	126,900	6,743			126,900	6,743
Tautog	33,400	1,211	244,750	8,068	278,150	9,279
Tomcod			2,400	90	2,400	90
Whiting	39,500	395	65,000	924	104,500	1,319
Miscellaneous fish	26,500	262	141,600	150	168,100	412
Shrimp			1,200	240	1,200	240
Lobsters	17,010	1,745	380,295	37,743	397,305	39,488
Crabs, hard			6,400	400	6,400	400
Crabs, soft			9,386	1,760	9,386	1,760
Clams	1,600	200	263,300	32,314	a 264,900	32,514
Quahogs	1,440	220	215,800	35,236	b 217,240	35,456
Scollaps	4,140	758	115,512	24,450	c 119,652	25,208
Oysters, market	3,141,131	486,263	474,222	75,028	d 3,615,353	561,291
Oysters, seed	116,200	7,682	524,650	19,079	e 640,850	26,761
Total	11,252,986	698,211	10,360,978	457,490	21,613,964	1,155,701

a 26,490 bushels. b 27,155 bushels. c 19,942 bushels. d 516,479 bushels. e 91,550 bushels.

THE FISHERIES BY COUNTIES.

All five of the counties of Rhode Island are interested in the coast fisheries.

Newport County has the most extensive fisheries, the number of persons employed being 862, the investment $583,421, and the products 13,778,347 pounds, valued at $387,934. Providence County, which is next in importance, had 447 persons employed, $209,504 invested, and a yield of 2,911,028 pounds, valued at $377,673. The fishery products of this county consisted chiefly of oysters.

Following are three tables giving the extent of the fisheries of the state for the year 1902, by counties:

Table showing by counties the number of persons employed in the fisheries of Rhode Island in 1902.

Counties.	On vessels fishing.	On vessels transporting.	Boat or shore fishermen.	Shoresmen.	Total.
Bristol	43		97	125	265
Kent	19		173	99	291
Newport	231	9	396	226	862
Providence	68	3	145	231	447
Washington	33	2	206	11	252
Total	394	14	1,017	692	2,117

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Rhode Island in 1902.

Items.	Bristol.		Kent.		Newport.		Providence.		Washington.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	12	$40,750	7	$9,545	39	$65,150	18	$73,450	3	$10,100
Tonnage	147		84		593		338		77	
Outfit		8,718		1,842		22,560		17,215		2,710
Vessels transporting					8	7,800	2	1,100	2	1,100
Tonnage					82		21		10	
Outfit						620		105		47
Boats	131	11,772	240	19,607	388	51,304	171	9,193	200	11,965
Apparatus—vessel fisheries:										
Pound nets and trap nets					22	40,800			16	13,400
Purse seines					1	500				
Gill nets			2	160	229	2,180				
Lines, hand and trawl						965				1
Pots, lobster					330	390				
Pots, eel			220	220						
Harpoons						217				
Dredges	38	1,015	30	246	4	100	64	1,960		
Tongs	40	192	11	48			59	280		
Apparatus—shore fisheries:										
Pound nets and trap nets	10	2,550	9	1,700	107	60,215			34	7,125
Seines			6	505	24	2,740	6	190	29	1,655
Gill nets	3	90	17	943	49	2,540			13	515
Fyke nets	72	372	302	1,870	164	832			163	1,142
Lines, hand and trawl		10		4		407		20		188
Pots, lobster	60	60	30	30	8,830	9,506			1,284	1,636
Pots, eel	530	320	860	552	260	310	1,120	659	980	827
Spears, eel	8	4	8	6	9	6	10	9	26	18
Dip nets							5	10	6	6
Dredges	129	759	612	1,772	222	704	129	449	116	364
Rakes	9	45	32	91	10	40	4	28	12	24
Tongs	94	392	144	782	8	40	122	518	54	183
Hoes	52	31	136	83	65	45	135	83	24	13
Shore and accessory property		43,100		14,100		204,200		93,735		4,100
Cash capital						109,250		10,500		
Total		110,180		54,106		583,421		209,504		57,069

Table showing by counties the products of the fisheries of Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore or horse mackerel					1,200	$16
Alewives, fresh	35,120	$621	9,800	$160	262,120	2,750
Blue-fish	450	27	14,280	907	123,680	7,961
Bonito			220	20	122,960	3,680
Butter-fish	11,800	377	14,100	448	317,210	9,010
Cod					649,460	19,413
Eels	54,500	2,705	117,040	5,690	38,700	1,627
Flat-fish and flounders	34,100	835	84,130	2,534	740,570	17,386
Haddock					466,695	13,080
Hickory shad					26,500	457
King-fish					1,730	228
Mackerel					512,480	28,602
Menhaden	35,000	130			416,000	826
Pollock					30,000	300
Scup	2,500	70	11,250	355	6,566,640	154,293
Sea bass					221,770	11,487
Shad	24,846	1,958	200	18	2,440	241
Spanish mackerel			150	22	260	42
Squeteague	61,770	2,132	136,030	4,368	2,165,225	49,826
Squid	600	13			84,050	2,318
Striped bass	110	13	100	10	28,460	3,110
Sword-fish					126,900	6,743
Tautog	36,500	1,254	38,000	1,210	164,850	5,247
Tomcod	500	25				
Whiting					104,500	1,319
Miscellaneous fish					162,000	262
Lobsters	2,000	320	1,600	220	351,955	34,359
Clams	30,700	3,795	94,000	11,555	15,400	1,600

Table showing by counties the product of the fisheries of Rhode Island in 1902—Cont'd.

Species.	Bristol.		Kent.		Newport.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Quahogs	35,080	$5,333	100,880	$16,864	23,720	$3,785
Scallops	9,480	1,783	69,720	15,665	22,032	4,258
Oysters, market	1,196,937	192,808	155,883	27,242	28,840	3,708
Oysters, seed	70,770	2,267	168,910	8,607		
Total	1,642,763	216,466	1,016,298	95,895	13,778,347	387,934

Species.	Providence.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Albacore or horse mackerel					1,200	$16
Alewives, fresh	8,550	$216	139,100	$1,520	454,690	5,267
Alewives, salted			166,800	2,099	166,800	2,099
Blue-fish			7,925	521	146,335	9,416
Bonito			2,000	160	125,180	3,860
Butter-fish			19,800	572	362,910	10,407
Cod			40,700	1,239	690,160	20,652
Eels	141,000	7,167	100,500	5,101	451,740	22,290
Flat-fish and flounders			276,070	7,084	1,134,870	27,839
Haddock			39,500	1,185	506,195	14,265
Hickory shad			8,260	248	34,760	700
King-fish			1,700	136	3,430	364
Mackerel			103,120	4,348	615,600	32,950
Menhaden			20,000	200	471,000	1,156
Minnows	2,000	120			2,000	120
Perch			40,400	2,395	40,400	2,395
Pollock					30,000	300
Scup			252,900	6,136	6,833,290	160,854
Sea bass			25,450	1,531	247,220	18,018
Shad			3,300	248	30,786	2,465
Smelt			10,600	942	10,600	942
Spanish mackerel					410	64
Squeteague	1,000	40	794,090	19,487	3,158,115	75,853
Squid			9,200	200	93,850	2,531
Striped bass			21,417	1,784	50,087	4,917
Sword-fish					126,900	6,743
Tautog	2,000	80	36,800	1,488	278,150	9,279
Tomcod			1,900	65	2,400	90
Whiting					104,500	1,319
Miscellaneous fish			6,100	150	168,100	412
Shrimp	1,200	240			1,200	240
Lobsters			41,750	4,589	397,305	39,488
Crabs, hard			6,400	400	6,400	400
Crabs, soft			9,386	1,760	9,386	1,760
Clams	112,800	14,102	12,000	1,462	264,900	32,514
Quahogs	55,440	9,092	2,120	382	217,240	35,456
Scallops	8,700	1,322	9,720	2,180	119,652	25,208
Oysters, market	2,177,168	329,407	56,525	8,126	3,615,353	561,291
Oysters, seed	401,170	15,887			640,850	26,761
Total	2,911,028	377,673	2,265,533	77,733	21,613,964	1,155,701

THE PRODUCTS BY APPARATUS.

The pound net and trap net are the most important forms of apparatus in Rhode Island for the capture of fish proper, yielding three-fourths of the total product in 1902. The number of these nets employed was 198, a decrease of 4 since 1898; but the value increased from $110,395 to $125,790. The catch in 1898 was 14,385,126 pounds, worth $220,791, and in 1902 12,924,261 pounds, for which the fishermen received $310,219, an increase per pound from 1.54 to 2.40 cents.

More than half of the pound-net and trap-net catch consists of scup, and nearly half of the remainder is squeteague. Other items of impor-

tance are flat-fish, flounders, mackerel, butter-fish, sea bass, alewives, bonito, striped bass, and tautog.

The gill-net, seine, and fyke-net fisheries have changed little since 1898, the most noticeable items being an increase in the catch of mackerel in gill nets at Block Island, an increase in the catch of mackerel and squeteague by seines, and a decrease in the take of menhaden by the same form of apparatus.

The line fisheries show a small decrease in yield since 1898, amounting to 1,972,116 pounds, worth $60,076 in that year, and 1,636,760 pounds, worth $52,870 in 1902. This decrease has been principally in the catch of cod, which in the former year amounted to 1,161,812 pounds, worth $31,907, and in the latter year was 606,450 pounds, for which the fishermen received $17,497. The line catch of blue-fish, mackerel, and sea bass also decreased, while that of haddock, flounders, squeteague, and tautog increased.

The yield of clams, quahogs, scallops, and oysters with dredges, tongs, etc., aggregated 4,857,995 pounds, exclusive of shells, and was valued at $681,230. Of this quantity, 3,264,511 pounds, valued at $495,123, was taken by vessels and 1,593,484 pounds, valued at $186,107, by boats in the shore fisheries. Since 1898 the value of the mollusk fisheries has increased $108,334. The greater part of this is in the yield of oysters, which has increased 150,651 bushels in quantity and $78,706 in value.

The following tables show, by counties, species, and apparatus, the quantity and value of products taken in the vessel and shore fisheries of Rhode Island in 1902:

Table showing by counties the yield of the seine fisheries of Rhode Island in 1902.

Species.	Kent.		Newport.		Providence.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Mackerel			3,150	$180					3,150	$180
Shore fisheries:										
Alewives, fresh	5,000	$75			1,200	$40	28,500	$405	34,700	520
Alewives, salted							166,800	2,099	166,800	2,099
Blue-fish	80	5							80	5
Bonito	100	8							100	8
Butter-fish	3,100	118							3,100	118
Eels	1,600	80			20,400	1,200	3,500	190	25,500	1,470
Flat-fish and flounders	2,000	70	36,000	480			14,850	552	52,850	1,102
Mackerel			204,100	9,460			1,200	90	205,300	9,550
Minnows					2,000	120			2,000	120
Perch							36,900	2,155	36,900	2,155
Scup	3,500	110							3,500	110
Shad							200	20	200	20
Smelt							6,800	638	6,800	638
Spanish mackerel	100	15							100	15
Squeteague	38,800	1,175	212,600	4,180			17,100	522	268,500	5,877
Striped bass	100	10					3,867	535	3,967	545
Tautog	8,000	290					1,000	50	9,000	340
Shrimp					1,200	240			1,200	240
Total	62,380	1,956	452,700	14,120	24,800	1,600	280,717	7,256	820,597	24,982
Total vessel and shore	62,380	1,956	455,850	14,300	24,800	1,600	280,717	7,256	823,747	25,112

Table showing by counties the yield of the gill-net fisheries of Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Blue-fish			1,000	$70					1,000	$70
Mackerel					78,350	$5,870			78,350	5,870
Squeteague			1,400	42	5,000	100			6,400	142
Total			2,400	112	83,350	5,970			85,750	6,082
Shore fisheries:										
Blue-fish	300	$18	13,200	832	50,260	3,414	4,250	$290	68,010	4,554
Bonito			120	12					120	12
Butter-fish					1,800	72			1,800	72
Mackerel					2,200	144			2,200	144
Spanish mackerel			50	7	40	10			90	17
Squeteague	2,750	110	13,700	471	71,000	1,970	14,000	525	101,450	3,076
Striped bass					50	7			50	7
Tautog	600	24							600	24
Total	3,650	152	27,070	1,322	125,350	5,617	18,250	815	174,320	7,906
Total vessel and shore	3,650	152	29,470	1,434	208,700	11,587	18,250	815	260,070	13,988

Table showing by counties the catch by pound nets and trap nets in Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Albacore or horse mackerel					1,200	$16			1,200	$16
Alewives							61,400	$556	61,400	556
Blue-fish					14,670	868	300	18	14,970	886
Butter-fish					24,560	746	8,700	208	33,260	954
Bonito							1,100	88	1,100	88
Cod					65,680	2,627	1,000	25	66,680	2,652
Eels							2,000	100	2,000	100
Flat-fish and flounders					223,250	5,931	69,750	1,630	293,000	7,561
Haddock					3,000	120			3,000	120
Hickory shad							900	27	900	27
King-fish					530	48	1,500	120	2,030	168
Mackerel					49,190	3,668	84,800	3,222	133,990	6,890
Menhaden					20,000	76	10,000	100	30,000	176
Scup					5,148,150	109,268	224,100	5,304	5,372,250	114,572
Sea bass					72,220	4,005	21,300	1,275	93,520	5,280
Shad					200	17	2,400	165	2,600	182
Spanish mackerel					220	32			220	32
Squeteague					237,540	5,798	355,700	8,946	593,240	14,744
Squid					15,700	391	9,000	194	24,700	585
Striped bass					15,160	1,516	15,350	1,041	30,510	2,557
Tautog					4,700	108	3,000	105	7,700	213
Whiting					39,500	395			39,500	395
Miscellaneous fish					22,000	152	4,500	110	26,500	262
Total					5,957,470	135,782	876,800	23,234	6,834,270	159,016
Shore fisheries:										
Alewives	35,120	$621	4,800	$85	262,120	2,750	49,200	559	351,240	4,015
Blue-fish	150	9			6,100	402	1,250	75	7,500	486
Bonito					122,960	3,680	900	72	123,860	3,752
Butter-fish	11,800	377	11,000	330	290,850	8,192	11,100	364	324,750	9,263
Cod					16,230	477	800	26	17,030	503
Eels	1,000	50			5,000	237	21,000	1,050	27,000	1,337
Flat-fish and flounders	6,100	155	12,000	360	358,020	8,114	121,450	2,830	497,570	11,459
Haddock					1,000	30			1,000	30
Hickory shad					26,500	457	7,360	216	33,860	673
King-fish					1,200	180	200	16	1,400	196
Mackerel					69,750	3,543	8,120	436	77,870	3,979
Menhaden	35,000	130			396,000	750	10,000	100	441,000	980
Perch							2,000	120	2,000	120
Pollock					30,000	300			30,000	300
Scup	2,500	70	7,750	245	1,418,490	45,025	27,400	776	1,456,140	46,116
Sea bass					140,450	7,022	2,300	126	142,750	7,148
Shad	24,846	1,958	200	18	2,240	224	700	63	27,986	2,263

Table showing by counties the catch by pound nets and trap nets in Rhode Island in 1902—Continued.

Species.	Bristol.		Kent.		Newport.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries—Con.										
Smelt							3,800	$304	3,800	$304
Squeteague	57,520	$1,962	64,330	$1,930	1,591,635	$86,761	897,040	9,119	2,110,525	49,772
Squid	600	13			68,350	1,927	200	6	69,150	1,946
Striped bass	110	13			13,250	1,587	2,200	208	15,560	1,808
Tautog	31,100	1,038	16,000	500	65,200	1,886	9,100	305	121,400	3,679
Whiting					65,000	924			65,000	924
Miscellaneous fish					140,000	110	1,600	40	141,600	150
Total	205,846	6,396	116,080	3,468	5,090,345	124,528	677,720	16,811	6,089,991	151,203
Total vessel and shore	205,846	6,396	116,080	3,468	11,047,815	260,310	1,554,520	40,045	12,924,261	310,219

Table showing by counties the yield of the fyke-net fisheries of Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Eels	400	$20					100	$5	500	$25
Flatfish and flounders	28,000	680	70,130	$2,104	30,200	$906	54,520	1,457	182,850	5,147
Perch							1,500	120	1,500	120
Tomcod	500	25					1,900	65	2,400	90
Total	28,900	725	70,130	2,104	30,200	906	58,020	1,647	187,250	5,382

Table showing by counties the yield of the line-fisheries of Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Providence.		Washington.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Vessel fisheries:												
Blue-fish					26,550	$1,583					26,550	$1,583
Cod					245,950	7,749					245,950	7,749
Flounders					81,100	1,690					81,100	1,690
Haddock					425,295	11,914					425,295	11,914
Mackerel					50,000	3,137					50,000	3,137
Sea bass					5,600	280					5,600	280
Squeteague					36,000	711					36,000	711
Tautog					23,200	898			2,500	$100	25,700	998
Total					893,695	27,962			2,500	100	896,195	28,062
Shore fisheries:												
Blue-fish					26,100	1,694			2,125	138	28,225	1,832
Cod					321,600	8,560			38,900	1,188	360,500	9,748
Eels	4,200	$210					14,500	$725	1,500	90	20,200	1,025
Flounders					12,000	265			15,500	615	27,500	880
Haddock					37,400	1,016			39,500	1,185	76,900	2,201
Mackerel					55,740	2,600			9,000	600	64,740	3,200
Scup									1,400	56	1,400	56
Sea bass					3,500	180			1,850	130	5,350	310
Squeteague	1,500	60	17,800	$750	11,450	306	1,000	40	10,250	375	42,000	1,531
Tautog	4,800	192	14,000	420	71,750	2,405	2,000	80	21,200	928	113,750	4,025
Total	10,500	462	31,800	1,170	539,540	17,026	17,500	845	141,225	5,305	740,565	24,808
Total vessel and shore	10,500	462	31,800	1,170	1,433,235	44,988	17,500	845	143,725	5,405	1,636,760	52,870

Table showing by counties the catch of eels and lobsters by pots in Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Providence.		Washington.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Vessel fisheries:												
Eels	......	......	25,200	$1,260	......	......	......	......	......	......	25,200	$1,260
Lobsters	......	......	......	......	$17,010	$1,745	......	......	......	......	17,010	1,745
Total	......	......	25,200	1,260	17,010	1,745	......	......	......	......	42,210	3,005
Shore fisheries:												
Eels	39,300	$1,945	81,040	3,890	26,950	1,010	96,700	$4,772	51,800	$2,526	295,790	14,143
Lobsters	2,000	320	1,600	220	334,945	32,614	......	......	41,750	4,589	380,295	37,743
Total	41,300	2,265	82,640	4,110	361,895	33,624	96,700	4,772	93,550	7,115	676,085	51,886
Total vessel and shore	41,300	2,265	107,840	5,370	378,905	35,369	96,700	4,772	93,550	7,115	718,295	54,891

Table showing by counties the catch by dredges, tongs, etc., in Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Clams	....	....	1,600	$200	....	....
Scallops	....	....	2,640	558	....	....
Oysters, market, private	843,255	$136,608	119,483	21,000	28,840	$3,708
Oysters, seed, private	....	....	45,500	3,060	....	....
Oysters, seed, public	....	....	12,250	490	....	....
Total	843,255	136,608	181,473	25,308	28,840	3,708
Shore fisheries:						
Clams	30,700	3,795	92,400	11,355	15,400	1,600
Quahogs	35,080	5,333	100,880	16,864	23,720	3,785
Scallops	9,480	1,783	67,080	15,107	22,032	4,258
Oysters, market, private	353,682	56,200	39,400	6,242	....	....
Oysters, seed, private	....	....	21,000	1,350	....	....
Oysters, seed, public	70,770	2,267	90,160	3,707	....	....
Total	499,712	69,378	407,920	54,625	61,152	9,643
Total vessel and shore	1,342,967	205,986	589,393	79,933	89,992	13,351

Species.	Providence.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Clams	....	....	....	....	1,600	$200
Quahogs	1,440	$220	....	....	1,440	220
Scallops	1,500	200	....	....	4,140	758
Oysters, market, private	2,149,553	324,947	....	....	3,141,131	486,263
Oysters, seed, private	56,000	4,000	....	....	101,500	7,060
Oysters, seed, public	2,450	132	....	....	14,700	622
Total	2,210,943	329,499	....	....	3,264,511	495,123
Shore fisheries:						
Clams	112,800	14,102	12,000	$1,462	263,300	32,314
Quahogs	54,000	8,872	2,120	382	215,800	35,236
Scallops	7,200	1,122	9,720	2,180	115,512	24,450
Oysters, market, private	27,615	4,460	43,925	6,890	461,622	73,792
Oysters, market, public	....	....	12,600	1,236	12,600	1,236
Oysters, seed, private	26,950	1,925	....	....	47,950	3,275
Oysters, seed, public	315,770	9,830	....	....	476,700	15,804
Total	544,335	40,311	80,365	12,150	1,593,484	186,107
Total vessel and shore	2,755,278	369,810	80,365	12,150	4,857,995	681,230

Table showing by counties the catch by spears and harpoons in the fisheries of Rhode Island in 1902.

Species.	Bristol.		Kent.		Newport.		Providence.		Washington.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:												
Sword-fish					126,900	$6,743					126,900	$6,743
Shore fisheries:												
Eels	9,600	$480	9,200	$460	6,750	380	9,400	$470	20,600	$1,140	55,550	2,930
Total	9,600	480	9,200	460	133,650	7,123	9,400	470	20,600	1,140	182,450	9,673

Table showing by counties the catch by dip nets in the fisheries of Rhode Island in 1902.

Species.	Providence.		Washington.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:						
Alewives	7,350	$176			7,350	$176
Crabs, hard			6,400	$400	6,400	400
Crabs, soft			9,386	1,760	9,386	1,760
Total	7,350	176	15,786	2,160	23,136	2,336

THE OYSTER INDUSTRY.

The oyster fishery yields in value more than half of the fishery products of Rhode Island. This industry has increased greatly since 1880, when 163,200 bushels were produced. In 1902 it gave employment to 694 persons and $291,892 worth of vessels, boats, apparatus, shore property, etc., and the product was valued at $588,052. The yield of the public or free fishery was small, amounting to 1,800 bushels of market oysters and 70,200 bushels of seed oysters. Owing to a complete lack of set in 1902, and again in 1903, the outlook for this branch of the fisheries in the next year or two is not favorable. Private oyster culture used 5,744 acres of ground in this state in 1902, and produced 21,350 bushels of seed oysters, 93,758 bushels of market oysters, and 420,921 gallons of opened oysters. the whole valued at $570,390.

Table showing by counties the extent of the oyster industry of Rhode Island in 1902-3.

Items.	Bristol.		Kent.		Newport.	
	No.	Value.	No.	Value.	No.	Value.
Persons engaged:						
On vessels and boats	99		50		3	
Shoresmen	123		23		3	
Total	222		73		6	
Steamers	10	$39,750	2	$7,500		
Tonnage	132		54			
Outfit		8,565		1,360		
Sail vessels	2	1,000	1	400		
Tonnage	15		6			
Outfit		153		182		
Boats (under 5 tons)	61	6,885	54	6,265	3	$640
Dredges	64	1,465	14	234	8	150

Table showing by counties the extent of the oyster industry of Rhode Island in 1902–3—Continued.

Items.	Bristol.		Kent.		Newport.	
	No.	Value.	No.	Value.	No.	Value.
Tongs and rakes	92	$402	52	$237		
Shore property		42,300		3,700		$300
Total investment		100,520		19,878		1,090
Oysters sold:						
Private, market .... bushels	42,891	63,552	10,779	15,570	4,120	3,708
Private, market .... gallons	128,100	129,256	11,490	11,672		
Private, seed .... bushels			9,500	4,410		
Public, seed .... do	10,110	2,267	14,630	4,197		
Total		195,075		35,849		3,708

Items.	Providence.		Washington.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Persons engaged:						
On vessels and boats	151		39		342	
Shoresmen	201		2		352	
Total	352		41		694	
Steamers	17	$73,000			29	$120,250
Tonnage	332				518	
Outfit		16,650				26,575
Sail vessels	1	450			4	1,850
Tonnage	6				27	
Outfit		90				425
Boats (under 5 tons)	93	5,975	41	$850	252	20,615
Dredges	70	2,040	4	28	160	3,917
Tongs and rakes	141	612	54	159	339	1,410
Shore property		68,850		1,700		116,850
Total		167,667		2,737		291,892
Oysters sold:						
Private, market .... bushels	34,893	46,882	1,075	1,620	93,758	131,332
Private, market .... gallons	276,131	282,525	5,200	5,270	420,921	428,723
Private, seed .... bushels	11,850	5,925			21,350	10,335
Public, market .... do			1,800	1,236	1,800	1,236
Public, seed .... do	45,460	9,962			70,200	16,426
Total		345,294		8,126		588,052

THE MENHADEN INDUSTRY.

Although one of the largest menhaden factories on the coast is located at Tiverton, R. I., producing nearly half a million dollars' worth of oil and fertilizer, very few menhaden are credited to the catch of this state. This is due to the fact that the factories are supplied by vessels owned in New York State.

Table showing the extent of the menhaden industry of Rhode Island in 1902.

Items.	No.	Value.
Factories	1	$175,000
Cash capital		100,000
Persons employed	195	
Menhaden received	114,757,900	172,137
Products prepared:		
Oil .... gallons	897,188	225,912
Scrap, acidulated .... tons	15,727	203,906
Value of products		429,818

Table showing the extent of the wholesale fish trade of Rhode Island in 1902.

Items.	No.	Value.
Establishments	6	$33,150
Cash capital	......	19,750
Wages paid	......	20,100
Persons engaged	36	....

FISHERIES OF CONNECTICUT.

The returns for the fisheries of Connecticut in 1902 show a slight increase over those for 1898. The number of men increased from 2,473 to 2,840, due almost entirely to the additional employees in the oyster-shucking houses. The persons actually employed in fishing increased only from 1,809 to 1,812. The value of vessels, boats, apparatus of capture, shore property, etc., decreased from $1,241,291 to $1,201,055.

The most noticeable change is in the value of the catch, which increased from $1,559,599 in 1898 to $1,799,381 in 1902, which is more than in any previous year for which statistics are available. In 1889 the value of the catch was $1,557,506, and in 1880 it was $1,456,866. There was an increase from 1898 to 1902 in the quantity of the products taken from 31,920,417 to 37,832,149 pounds, due principally to the greater catch of menhaden, the yield of which in 1898 was 11,182,910 pounds, against 16,876,690 pounds in 1902. Considering only the products used for food, the quantity in 1902 was only 1 per cent greater than in 1898. The average value of the food species in 1898 was 7.39 cents and in 1902 8.36 cents per pound.

The principal items in the fishery products of Connecticut are seed and market oysters; in 1902 1,233,469 bushels of the former, worth $598,948, were taken, and 848,065 bushels of the latter, worth $872,634. The seed oysters were sold for planting in New York, Rhode Island, Massachusetts, California, and other states; 182,913 bushels of market oysters, worth $174,158, were sold in the shell, principally for export to Europe, and the remainder were opened before shipment. Of the above quantities, the public or free grounds yielded 35,676 bushels of seed, worth $11,875, and 9,880 bushels of market oysters, worth $5,877, the remainder coming from the cultivated grounds. Owing to a lack of set during the last four years the present outlook for the oyster industry in Connecticut is not especially gratifying.

The yield of quahogs or hard clams has decreased from 29,250 bushels, worth $1.02 per bushel in 1898, to 18,927 bushels, worth $1.31 per bushel in 1902. In the last year or two several oyster planters have given some attention to planting quahogs, and it seems probable that this may result in a largely increased output in a few

years. The product of soft clams has increased in the same period from 19,980 bushels, worth $19,039, to 22,460 bushels, worth $26,743.

The yield of menhaden shows an increase from 11,182,910 pounds in 1898 to 16,876,690 pounds in 1902, due to a greater abundance of the fish in Long Island Sound. This, however, is less than 25 per cent of the yield in 1889, when there were 4 factories in operation in this state.

The lobster fishery of Connecticut has shown a steady decline since 1889. In that year the product was 1,501,290 pounds, in 1898 it was 1,098,192 pounds, and in 1902, 371,650 pounds. The value per pound has correspondingly increased, being 5.53 cents in 1889, 7.63 cents in 1898, and 10.96 cents in 1902. A large percentage of the lobster fishermen now use small power boats, which are especially serviceable in this fishery.

The catch of shad in 1902 amounted to 479,780 pounds, worth $26,003, whereas in 1898 it was 499,325 pounds, worth $21,215. The catch in the Connecticut River was especially large, but in the Housatonic River the fishery is practically at an end, only 6 shad being taken there in the year reported.

The alewife fishery in Connecticut has increased very largely, 1,663,153 pounds being secured in 1902, against 868,400 pounds in 1898, and 53,272 pounds in 1889.

Mackerel, haddock, scup, squeteague, striped bass, suckers, and tautog show an increase in yield, but the quantity of blue-fish, cod, and sea bass has decreased. The red snappers reported in 1902 were taken off the port of Charleston, S. C., by a Noank vessel.

The following series of tables show the number of persons engaged, the number and value of vessels and boats, the quantity and value of fishing apparatus, the value of shore and accessory property, the amount of cash capital employed, and the quantity and value of the products of the fisheries of Connecticut in 1902:

Persons employed.

How engaged.	No.
On vessels fishing	749
On vessels transporting	53
In shore or boat fisheries	1,063
Shoresmen	975
Total	2,840

Table of apparatus and capital.

Items.	No.	Value.
Vessels fishing	170	$456,230
Tonnage	3,375	
Outfit		143,168
Vessels transporting	24	24,850
Tonnage	421	
Outfit		2,680
Boats	1,175	71,474
Apparatus—vessel fisheries:		
Seines	5	2,700
Gill nets	150	1,355
Lobster pots	1,710	3,525
Eel pots	80	80
Lines		1,196
Harpoons		360
Dredges	554	8,533
Rakes	34	168
Tongs	8	40
Apparatus—shore fisheries:		
Seines	88	$6,212
Gill nets	111	5,234
Pound nets	77	18,140
Fyke nets	255	3,148
Eel pots	1,575	1,491
Lobster pots	5,103	8,956
Spears	59	41
Lines		194
Harpoons		15
Dredges	214	1,252
Rakes	154	815
Tongs	196	933
Hoes	358	250
Dip nets	40	20
Shore and accessory property		330,995
Cash capital		107,000
Total		1,201,055

Table of products.

Species.	Vessel fisheries.		Shore fisheries.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives			1,663,153	$15,399	1,663,153	$15,399
Blue-fish	323,350	$16,326	25,225	1,507	348,575	17,833
Bullheads			8,035	303	8,035	303
Butter-fish			67,218	2,304	67,218	2,304
Carp, German			2,134	164	2,134	164
Cod	202,340	6,767	9,000	290	211,340	7,057
Eels	12,000	960	220,324	13,716	232,324	14,676
Flat-fish			240,720	7,854	240,720	7,854
Flounders	45,280	1,569	223,289	6,261	268,569	7,830
Haddock	169,150	5,297	20,000	600	189,150	5,897
King-fish			1,500	105	1,500	105
Mackerel	142,790	8,123	157,900	7,806	300,690	15,929
Menhaden	14,398,980	37,932	2,477,710	10,032	16,876,690	47,964
Perch			33,635	1,525	33,635	1,525
Pickerel			8,230	530	8,230	530
Pollock	4,300	144			4,300	144
Salmon			18	9	18	9
Scup	211,800	8,472	184,540	5,125	396,340	13,597
Sea bass	81,970	4,396	50,510	3,384	132,480	7,780
Shad			479,780	26,003	479,780	26,003
Smelt			2,850	432	2,850	432
Snappers, red	68,750	2,750			68,750	2,750
Squeteague	400	15	407,320	11,502	407,720	11,517
Striped bass			40,422	3,850	40,422	3,850
Sturgeon			6,745	482	6,745	482
Suckers			122,757	4,519	122,757	4,519
Sun-fish			9,020	380	9,020	380
Sword-fish	162,730	8,658	3,200	160	165,930	8,818
Tautog	17,150	678	96,985	3,859	114,135	4,537
Tomcod, or frost-fish			27,330	1,188	27,330	1,188
Whiting			31,270	461	31,270	461
Squid			37,535	538	37,535	538
Lobsters	93,030	10,009	278,620	30,710	371,650	40,719
Oysters, market	5,335,617	792,295	600,838	80,339	a 5,936,455	872,634
Oysters, seed	8,441,013	590,138	193,270	8,810	b 8,634,283	598,948
Clams			224,600	26,743	c 224,600	26,743
Quahogs	25,000	3,936	126,416	20,826	d 151,416	24,762
Scallops			14,400	3,200	e 14,400	3,200
Total	29,735,650	1,498,465	8,096,499	300,916	37,832,149	1,799,381

a 848,065 bushels. b 1,233,469 bushels. c 22,460 bushels. d 18,927 bushels. e 2,400 bushels.

THE FISHERIES BY COUNTIES.

The five counties of Connecticut interested in the coast fisheries are Fairfield, Hartford, Middlesex, New Haven, and New London. All of these reach Long Island Sound except Hartford, on the Connecticut River. New Haven County ranks first in the importance of its fish-

eries, having 1,066 persons employed, $517,202 invested, and products amounting to 9,302,914 pounds, valued at $833,276. The fisheries of Fairfield County are nearly as extensive as those of New Haven, the number of persons employed being 951, the investment $446,666, and the products 8,074,016 pounds, valued at $711,879. The quantity of products is greatest in New London County because it includes the greater part of the yield of menhaden.

The extent of the fisheries in each county of the state in 1902 is shown in the following tables:

Table showing by counties the number of persons employed in the fisheries of Connecticut in 1902.

Counties.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Fairfield	366	24	306	255	951
Hartford	....	....	93	11	104
Middlesex	....	....	239	....	239
New Haven	193	24	184	665	1,066
New London	190	5	241	44	480
Total	749	53	1,063	975	2,840

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Connecticut in 1902.

Items.	Fairfield.		Hartford.		Middlesex.		New Haven.		New London.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	101	$227,130	....	......	....	......	33	$161,100	36	$68,000	170	$456,230
Tonnage	1,578	......	....	......	....	......	1,127	......	670	......	3,375	......
Outfit	....	52,548	....	......	....	......	....	64,415	....	26,205	....	143,168
Vessels transporting	12	10,950	....	......	....	......	10	11,800	2	2,100	24	24,850
Tonnage	118	......	....	......	....	......	228	......	75	......	421	......
Outfit	....	1,215	....	......	....	......	....	1,290	....	175	....	2,680
Boats	374	20,920	63	$1,665	217	$10,456	252	11,603	269	26,830	1,175	71,474
Apparatus—vessel fisheries:												
Seines	....	......	....	......	....	......	....	......	5	2,700	5	2,700
Gill nets	....	......	....	......	....	......	....	......	150	1,355	150	1,355
Lobster pots	....	......	....	......	....	......	....	......	1,710	3,525	1,710	3,525
Eel pots	80	80	....	......	....	......	....	......	....	......	80	80
Lines	....	......	....	......	....	......	....	......	....	1,196	....	1,196
Harpoons	....	40	....	......	....	......	....	......	....	320	....	360
Dredges	422	5,408	....	......	....	......	132	3,125	....	......	554	8,533
Rakes	29	143	....	......	....	......	....	......	5	25	34	168
Tongs	....	......	....	......	....	......	8	40	....	......	8	40
Apparatus—shore fisheries:												
Seines	10	625	30	3,175	32	1,867	4	170	12	375	88	6,212
Gill nets	2	55	12	313	69	3,096	....	......	28	1,770	111	5,234
Pound nets	....	......	....	......	4	2,100	11	4,950	62	11,090	77	18,140
Fyke nets	39	955	6	65	28	226	12	280	170	1,622	255	3,148
Eel pots	412	527	....	......	319	283	457	407	387	274	1,575	1,491
Lobster pots	335	472	....	......	780	1,185	1,031	1,673	2,957	5,626	5,103	8,956
Spears	23	16	....	......	10	5	11	9	15	11	59	41
Lines	....	......	....	......	....	22	....	2	....	170	....	194
Harpoons	....	......	....	......	....	......	....	......	....	15	....	15
Dredges	198	1,136	....	......	....	......	16	116	....	......	214	1,252
Rakes	131	712	....	......	....	......	16	80	7	23	154	815
Tongs	44	218	....	......	42	210	85	401	25	104	196	933
Hoes	178	116	....	......	39	29	121	91	20	14	358	250
Dip nets	40	20	....	......	....	......	....	......	....	......	40	20
Shore and accessory property	....	86,880	....	1,460	....	1,990	....	209,150	....	31,515	....	330,995
Cash capital	....	36,500	....	......	....	......	....	46,500	....	24,000	....	107,000
Total	....	446,666	....	6,678	....	21,469	....	517,202	....	209,040	....	1,201,055

Table showing by counties the products of the fisheries of Connecticut in 1902.

Species.	Fairfield.		Hartford.		Middlesex.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives			1,168,468	$9,862	247,517	$2,232
Blue-fish					15,100	920
Bullheads			2,985	119	1,900	82
Butter-fish	150	$9			1,400	50
Carp, German			1,680	131	454	33
Eels	83,556	6,248	510	31	36,560	1,839
Flat-fish	9,650	396			11,900	353
Flounders	1,500	75			20,020	621
Mackerel					12,000	720
Menhaden					191,160	4,082
Perch			11,400	464	15,695	773
Pickerel			1,030	80	3,930	304
Scup					5,500	185
Sea-bass					7,100	281
Shad	24	2	73,192	3,743	280,224	15,444
Smelt	2,850	432				
Squeteague	1,650	79			13,600	439
Striped bass	9,020	1,244	40	5	4,692	506
Sturgeon			600	22	1,220	127
Suckers			50,647	2,025	43,946	1,684
Sun-fish			900	36	1,960	87
Sword-fish	14,400	720				
Tautog	1,550	75			15,160	750
Tomcod or frost-fish	17,950	881				
Lobsters	12,940	2,124			29,125	3,555
Oysters, market	1,860,481	247,306			13,370	1,630
Oysters, seed	5,830,335	417,407			26,250	984
Clams	85,800	10,636			14,200	1,955
Quahogs	127,760	21,045			96	18
Scallops	14,400	3,200				
Total	8,074,016	711,879	1,301,896	16,013	1,014,079	39,654

Species.	New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Alewives	20,390	$286	226,778	$3,019	1,663,153	$15,399
Blue-fish	1,015	51	332,460	16,862	348,575	17,833
Bullheads			3,150	102	8,035	303
Butter-fish	5,758	247	59,910	1,998	67,218	2,304
Carp, German					2,134	164
Cod			211,340	7,057	211,340	7,057
Eels	42,410	2,956	69,288	3,602	232,324	14,676
Flat-fish	30,595	1,017	188,575	6,088	240,720	7,854
Flounders	9,070	273	237,979	6,861	268,569	7,830
Haddock			189,150	5,897	189,150	5,897
King-fish			1,500	105	1,500	105
Mackerel	100	10	288,590	15,199	300,690	15,929
Menhaden	2,166,610	5,079	14,518,920	38,803	16,876,690	47,964
Perch			6,540	288	33,635	1,525
Pickerel			3,270	146	8,230	530
Pollock			4,300	144	4,300	144
Salmon	8	4	10	5	18	9
Scup			390,840	13,412	396,340	13,597
Sea bass	500	30	124,880	7,469	132,480	7,780
Shad	4,372	381	121,968	6,433	479,780	26,003
Smelt					2,850	432
Snappers, red			68,750	2,750	68,750	2,750
Squeteague	33,044	847	359,426	10,152	407,720	11,517
Striped bass	2,650	339	24,020	1,756	40,422	3,850
Sturgeon	740	34	4,185	299	6,745	482
Suckers			28,164	810	122,757	4,519
Sun-fish			6,160	257	9,020	380
Sword-fish			151,530	8,098	165,930	8,818
Tautog	5,935	274	91,490	3,438	114,135	4,537
Tomcod or frost-fish	3,400	112	5,980	195	27,330	1,188
Whiting	20	1	31,250	460	31,270	461
Squid			37,535	538	37,535	538
Lobsters	37,445	5,112	292,140	29,928	371,650	40,719
Oysters, market	4,035,094	620,638	27,510	3,060	5,936,455	872,634
Oysters, seed	2,777,698	180,557			8,634,283	598,948
Clams	112,100	12,712	12,500	1,440	224,600	26,743
Quahogs	13,960	2,316	9,600	1,383	151,416	24,762
Scallops					14,400	3,200
Total	9,302,914	833,276	18,129,688	198,054	37,832,149	1,799,381

THE PRODUCTS BY APPARATUS.

The catch with purse and haul seines in the vessel and shore fisheries amounted to 16,326,866 pounds, valued at $72,506. This included 14,398,980 pounds of menhaden, worth $37,932. Gill nets took 432,095 pounds of various species, valued at $23,038; pound nets, 3,812,573 pounds, $50,826; fyke nets, 309,011 pounds, $8,929; lines, 1,221,800 pounds, $53,576; pots, 556,670 pounds, $52,268; dredges, tongs, etc., employed in the mollusk fisheries, 14,961,154 pounds, $1,526,287; and spears and harpoons, 211,980 pounds, $11,951.

The following tables show by counties and species the quantity and value of products taken with each form of fishing apparatus in the vessel and shore fisheries of Connecticut in 1902:

Table showing by counties the yield of the seine fisheries of Connecticut in 1902.

Species.	Fairfield.		Hartford.		Middlesex.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:						
Alewives			1,168,228	$9,857	242,857	$2,149
Bullheads			2,985	119	1,840	79
Carp, German			1,680	131	454	33
Eels			510	31	160	9
Flat-fish	300	$12				
Perch			11,000	456	13,095	643
Pickerel			1,030	80	2,830	249
Shad			63,636	3,238	32,496	1,769
Smelt	2,850	432				
Squeteague	500	23				
Striped bass	4,120	621	40	5	3,840	399
Sturgeon			600	22		
Suckers			49,047	1,961	38,496	1,509
Sun-fish			900	36	960	47
Tomcod, or frost-fish	6,200	248				
Total	13,970	1,336	1,299,656	15,936	337,028	6,886

Species.	New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:						
Scup			200,000	$8,000	200,000	$8,000
Menhaden			14,398,980	37,932	14,398,980	37,932
Total			14,598,980	45,932	14,598,980	45,932
Shore fisheries:						
Alewives	7,200	$110	30,208	562	1,448,493	12,678
Bullheads			2,400	72	7,225	270
Carp, German					2,134	164
Eels			850	43	1,520	83
Flat-fish			720	29	1,020	41
Flounders			300	12	300	12
Perch			3,240	132	27,335	1,231
Pickerel			1,870	76	5,730	405
Shad	2,480	217			98,612	5,224
Smelt					2,850	432
Squeteague	9,500	190	640	27	10,640	240
Striped bass	350	44	5,520	568	13,870	1,637
Sturgeon					600	22
Suckers			9,164	222	96,707	3,692
Sun-fish			2,760	111	4,620	194
Tomcod, or frost-fish			30	1	6,230	249
Total	19,530	561	57,702	1,855	1,727,886	26,574
Total vessel and shore	19,530	561	14,656,682	47,787	16,326,866	72,506

Table showing by counties the yield of the gill-net fisheries of Connecticut in 1902.

Species.	Fairfield.		Hartford.		Middlesex.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Mackerel							86,040	$4,780	86,040	$4,780
Shore fisheries:										
Alewives					1,420	$28			1,420	28
Blue-fish					3,200	192			3,200	192
Shad	24	$2	9,556	$505	204,100	10,862	119,340	6,281	333,020	17,600
Squeteague	250	15			6,000	180			6,250	195
Sturgeon					580	97	1,585	146	2,165	2[illegible]
Total	274	17	9,556	505	215,300	11,359	120,925	6,377	346,055	18,258
Total vessel and shore	274	17	9,556	505	215,300	11,359	206,965	11,157	432,095	23,038

Table showing by counties the yield of the pound-net fisheries of Connecticut in 1902.

Species.	Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:								
Alewives	3,240	$55	13,190	$176	69,890	$810	86,320	$1,041
Blue-fish			15	1	6,210	360	6,225	361
Butter-fish	1,400	50	5,758	247	59,910	1,998	67,068	2,295
Eels			50	3	1,088	58	1,138	61
Flat-fish	7,900	233	5,595	167	125,365	3,942	138,860	4,342
Flounders	5,820	175	9,070	273	178,654	4,762	193,544	5,210
King-fish					1,500	105	1,500	105
Mackerel			100	10	87,200	3,972	87,300	3,982
Menhaden	191,160	4,082	2,166,610	5,079	119,940	871	2,477,710	10,032
Salmon			8	4	10	5	18	9
Scup					179,040	4,940	179,040	4,940
Sea bass					18,490	1,043	18,490	1,043
Shad	43,628	2,813	1,892	164	2,628	202	48,148	3,179
Squeteague	2,600	69	22,244	605	347,976	9,733	372,820	10,407
Striped bass	52	7	40	6	18,160	1,154	18,252	1,167
Sturgeon	640	30	740	34	2,600	153	3,980	217
Tautog	760	30	1,735	76	36,740	1,197	39,235	1,303
Tomcod or frost-fish					4,120	133	4,120	133
Whiting			20	1	31,250	460	31,270	461
Squid					37,535	538	37,535	538
Total	257,200	7,544	2,227,067	6,846	1,328,306	36,436	3,812,573	50,826

Table showing by counties the yield of the fyke-net fisheries of Connecticut in 1902.

Species.	Fairfield.		Hartford.		Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Shore fisheries:												
Alewives			240	$5					126,680	$1,647	126,920	$1,652
Blue-fish							1,000	$50			1,000	50
Bullheads					60	$3			750	30	810	33
Butter-fish	150	$9									150	9
Eels	216	13			400	20	950	57	1,250	65	2,816	155
Flat-fish	9,350	384			4,000	120	25,000	850	62,490	2,117	100,840	3,471
Flounders									4,145	135	4,145	135
Perch			400	8	2,600	130			3,300	156	6,300	294
Pickerel					1,100	55			1,400	70	2,500	125
Squeteague	900	41					1,300	52	2,910	77	5,110	170
Striped bass	4,900	623					1,260	164	340	34	6,500	821
Suckers			1,600	64	5,450	175			19,000	588	26,050	827
Sun-fish					1,000	40			3,400	146	4,400	186
Tautog	1,550	75					1,200	48	1,740	72	4,490	195
Tomcod or frost-fish	11,750	633					3,400	112	1,830	61	16,980	806
Total	28,816	1,778	2,240	77	14,610	543	34,110	1,333	229,235	5,198	309,011	8,929

Table showing by counties the yield of the line fisheries of Connecticut in 1902.

Species.	Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:								
Blue-fish					323,350	$16,326	323,350	$16,326
Cod					202,340	6,767	202,340	6,767
Flounders					45,280	1,569	45,280	1,569
Haddock					169,150	5,297	169,150	5,297
Mackerel					56,750	3,343	56,750	3,343
Pollock					4,300	144	4,300	144
Scup					11,800	472	11,800	472
Sea bass					80,850	4,308	80,850	4,308
Snappers, red					68,750	2,750	68,750	2,750
Squeteague					400	15	400	15
Tautog					17,150	678	17,150	678
Total					980,120	41,669	980,120	41,669
Shore fisheries:								
Blue-fish	11,900	$728			2,900	176	14,800	904
Cod					9,000	290	9,000	290
Flounders	14,200	446			9,600	383	23,800	829
Haddock					20,000	600	20,000	600
Mackerel	12,000	720			58,600	3,101	70,600	3,824
Scup	5,500	185					5,500	185
Sea bass	7,100	281	500	$30	22,820	1,888	30,420	2,199
Squeteague	5,000	190			7,500	300	12,500	490
Striped bass	800	100	1,000	125			1,800	225
Tautog	14,400	720	3,000	150	35,860	1,491	53,260	2,361
Total	70,900	3,370	4,500	305	166,280	8,232	241,680	11,907
Total vessel and shore	70,900	3,370	4,500	305	1,146,400	49,901	1,221,800	53,576

Table showing by counties the catch by pots in the fisheries of Connecticut in 1902.

Species.	Fairfield.		Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Eels	12,000	$960							12,000	$960
Sea bass							1,120	$88	1,120	88
Lobsters							93,030	10,009	93,030	10,009
Total	12,000	960					94,150	10,097	106,150	11,057
Shore fisheries:										
Eels	51,690	3,650	26,400	$1,330	36,310	$2,555	55,900	2,824	170,300	10,359
Sea bass							1,600	142	1,600	142
Lobsters	12,940	2,124	29,125	3,555	37,445	5,112	199,110	19,919	278,620	30,710
Total	64,630	5,774	55,525	4,885	73,755	7,667	256,610	22,885	450,520	41,211
Total vessel and shore	76,630	6,734	55,525	4,885	73,755	7,667	350,760	32,982	556,670	52,268

Table showing by counties the catch by dredges, tongs, rakes, etc., in Connecticut in 1902.

Species.	Fairfield.		Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Oysters, market, private	1,681,421	$227,892			3,643,416	$563,695			5,324,837	$791,587
Oysters, market, public	10,780	708							10,780	708
Oysters, seed, private	5,633,803	407,448			2,730,168	178,379			8,363,971	585,827
Oysters, seed, public	77,042	4,311							77,042	4,311
Quahogs	17,160	2,809					7,840	$1,127	25,000	3,936
Total	7,420,206	643,168			6,373,584	742,074	7,840	1,127	13,801,630	1,386,369

Table showing by counties the catch by dredges, tongs, rakes, etc., in Connecticut in 1902—Continued.

Species.	Fairfield.		Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Shore fisheries:										
Oysters, market, private	154,560	$17,861	5,250	$750	362,698	$54,039	19,950	$2,520	542,458	$75,170
Oysters, market, public	13,720	845	8,120	880	28,980	2,904	7,560	540	58,380	5,169
Oysters, seed, private			2,100	120	18,480	1,126			20,580	1,246
Oysters, seed, public	119,490	5,648	24,150	864	29,050	1,052			172,690	7,564
Clams	85,800	10,636	14,200	1,955	112,100	12,712	12,500	1,440	224,600	26,743
Quahogs	110,600	18,236	96	18	13,960	2,316	1,760	256	126,416	20,826
Scallops	14,400	3,200							14,400	3,200
Total	498,570	56,426	53,916	4,587	565,268	74,149	41,770	4,756	1,159,524	139,918
Total vessel and shore	7,918,776	699,594	53,916	4,587	6,938,852	816,223	49,610	5,883	14,961,154	1,526,287

Table showing by counties the catch by spears and harpoons in the fisheries of Connecticut in 1902.

Species.	Fairfield.		Middlesex.		New Haven.		New London.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Vessel fisheries:										
Sword-fish	14,400	$720					148,330	$7,938	162,730	$8,658
Shore fisheries:										
Eels	19,650	1,625	9,600	$480	5,100	$341	10,200	612	44,550	3,058
Flounders	1,500	75							1,500	75
Sword-fish							3,200	160	3,200	160
Total	21,150	1,700	9,600	480	5,100	341	13,400	772	49,250	3,293
Total vessel and shore	35,550	2,420	9,600	480	5,100	341	161,730	8,710	211,980	11,951

Table showing by counties the extent of the oyster industry of Connecticut in 1902–3.

Items.	Fairfield.		Middlesex.		New Haven.		New London.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Persons engaged:										
On vessels and boats	499		42		279		31		851	
Shoresmen	189				638				827	
Total	688		42		917		31		1,678	
Steamers	38	$198,250			33	$162,450			71	$360,700
Tonnage	1,130				1,121				2,251	
Outfit		48,975				64,490				113,465
Sail vessels	74	39,430			7	9,100	1	$1,800	82	50,330
Tonnage	560				194		70		824	
Outfit		4,518				1,115		150		5,783
Boats (under 5 tons)	130	15,380	43	$660	89	4,658	31	1,109	293	21,807
Dredges	620	6,544			148	1,241			768	7,785
Tongs and rakes	44	218	42	210	85	401	29	112	200	941
Shore property		85,260		450		201,150		380		287,240
Total investment		398,575		1,320		444,605		3,551		848,051
Oysters sold:										
Private, market . bush	150,168	142,173	1,750	750	18,265	22,838	2,850	2,520	173,033	168,281
Private, market . galls	112,115	103,580			554,037	594,896			666,152	698,476
Private, seed . . bush	804,829	407,448	300	120	392,664	179,505			1,179,793	587,073
Public, market . do	3,500	1,553	1,160	880	4,140	2,904	1,080	540	9,880	5,877
Public, seed . . . . do	28,076	9,959	3,450	864	4,150	1,052			35,676	11,875
Total		664,713		2,614		801,195		3,060		1,471,582

NOTE.—Investment does not include planting ground or oysters thereon.

Table showing the extent of the menhaden industry of Connecticut in 1902.

Items.	No.	Value.
Factories in operation	2	$24,000
Cash capital	....	24,000
Factory employees	40	....
Men on vessels	45	....
Steam vessels fishing	2	14,500
Tonnage	133	....
Outfit	....	8,175
Seines used on vessels	2	1,500
Menhaden utilized	26,340,800	40,511
Products prepared:		
Oil .... gallons	194,606	45,763
Dry scrap .... tons	458	11,918
Acidulated scrap .... do	1,320	17,160
Green scrap .... do	352	5,280
Value of products	....	80,121

Table showing the extent of the wholesale fish trade of Connecticut in 1902.

Items.	No.	Value.
Establishments	5	$22,500
Cash capital	....	83,000
Wages paid	....	23,800
Persons engaged	93	....

NOTES ON THE FISHES OF THE STREAMS FLOWING INTO SAN FRANCISCO BAY, CALIFORNIA

By JOHN OTTERBEIN SNYDER
Assistant Professor of Zoology, Leland Stanford Junior University

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The territory drained by the streams flowing into San Francisco Bay comprises a catchment basin which is partly bounded by mountain ranges of considerable height. It is thus sharply separated on the east from the San Joaquin Valley, and on the west from a much more restricted area drained by a series of small streams flowing directly to the ocean. On the south a comparatively low, though perfectly distinct, watershed divides it from the valley of the Pajaro River. All of the streams connected with the bay are to be considered as belonging to a single system, none apparently having remained isolated for any considerable period of time. Complete isolation is prevented by an occasional intermingling of the waters of two or more streams near their mouths, and also by a reduction of the salinity of the water of the bay during periods of excessive rainfall, the surface at such times occasionally becoming quite fresh.

Most of the streams of this basin converge toward the southern end of the bay, which is there bordered by extensive salicornia marshes. The constant wash of the tides has cut into the surface of these marshes a network of sloughs, to some of which the water from the creeks eventually finds its way. Before reaching the sloughs, however, this water often spreads out, forming large ponds. The union of two or more of these temporary ponds, the shifting of a creek channel caused by some obstruction, the change in the direction of a slough, or a combination of these conditions may form between two streams a continuous passage well adapted for the migration of fresh-water fishes.[a] Such a union of two creeks has actually been observed, one of them as a result having become stocked with an additional species. A dense growth of willows recently deflected San Francisquito Creek to the

[a] Such conditions are possible only during the height of the rainy season. On the approach of the dry season all the streams of the region rapidly shrink, both in volume and length, only one of them, Coyote Creek, discharging water into the bay during the entire summer. Much of its bed is dry, however, for part of the year, the water sinking soon after leaving the mountains, and appearing again about 2 miles above its mouth.

southward so far that a fresh-water passage could easily be traced through a succession of small ponds between it and Madera Creek. Shortly afterwards suckers (*Catostomus occidentalis*) appeared in the latter creek, where they had not previously been seen, although the stream had been under observation for eight years.[a]

Not only is it apparent that the streams flowing into San Francisco Bay are intimately connected, but it is also probable that the basin as such is really a part of the great Sacramento-San Joaquin system. The only channel for communication with the latter is through the salt waters of San Pablo and Suisun bays. But conditions obtaining in this passage are greatly modified during periods of exceptional rainfall, when the drainage water from a large part of the state flows through it. It is possible that at such a time the salt-water barrier of the bays, though generally effective, may be broken down and an opportunity offered for the extensive migration of fresh-water fishes. Ayres[b] has shown that such migrations actually occur. He records several fresh-water species as having been taken in various parts of the bay of San Francisco during the unusual floods of 1862. He also adds that snakes, even, were cast up alive on the beach.

Thirteen species of fishes have been collected from the streams tributary to San Francisco Bay. All are identical with forms found in the Sacramento and San Joaquin rivers, a careful comparison of specimens from the two basins having revealed no structual differences whatever. Four of these species, belonging respectively to the genera *Entosphenus*, *Salmo*, *Gasterosteus*, and *Cottus*, are able to withstand salt water and may frequently pass out into the bay. The others are apparently able at certain times to pass between neighboring streams, and occasionally to take advantage of an open channel for migration between this basin and the Sacramento.

The relation existing between species found in this basin and that of the Pajaro River to the southward remains to be discovered. The results of an examination of the coastwise creeks to the north of Monterey Bay will also be of great interest.

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[a] Madera Creek occasionally becomes so reduced in size during the dry season that its water might be held in a few barrels and its entire ichthic fauna easily placed in a pint cup. The presence of a species in such a stream could hardly escape an interested observer.

[b] Ayres, Dr. W. O., Proceedings California Academy Natural Sciences, Vol. II, p. 163. (Feb. 3, 1862.) "For the last two months the fishermen who supply the markets of this city with fish have taken in the bay of San Francisco many fresh-water fishes, of species generally found in the *rivers*, not those inhabiting the smaller creeks. These have been caught at all the various points of the bay at which salt-water fishes only have previously been found. It is well known that the surface waters of the bay have been nearly fresh during these floods, and the fishes in question must have followed down and lived this length of time in the fresh surface water. They have not been seen in the bay before this. The following species have been noticed:

Archoplites interruptus.	Algansea formosa.
Catostomus occidentalis.	Lavinia compressa.
Catostomus labiatus.	Ptychocheilus grandis.
Orthodon microlepidotus.	Mylopharodon robustus."

Mr. Charles A. Vogelsang, chief deputy California Fish Commission, under date Jan. 24, 1905, writes: "There is no question but that at this season of the year suckers, catfish, carp, and black bass can be found in the waters of the bay on the Berkeley shore and on the east side of Angel Island."

CATALOGUE OF SPECIES.

1. **Entosphenus tridentatus** (Gairdner).

Taken by Mr. A. C. Herre in Coyote Creek, March, 1905.

2. **Catostomus occidentalis** Ayres.

San Francisquito, Madera, San Antonio, Stevens, Campbell, Guadalupe, Coyote, Alameda, Arroyo Honda, Smith, and Isabel creeks.

The species disappears from Madera Creek during periods of great drouth, returning when conditions are favorable.

3. **Orthodon microlepidotus** (Ayres).

Coyote Creek.

4. **Lavinia exilicauda** Baird & Girard.

Coyote and Alameda creeks.

5. **Pogonichthys macrolepidotus** (Ayres).

Coyote Creek.

6. **Ptychocheilus grandis** Girard.

This species differs from *P. oregonensis*, its representative in the Columbia basin, in having fewer dorsal rays (8 in *P. grandis*, 9 in *P. oregonensis*) and larger scales above the lateral line (13 to 17 rows compared with 17 to 21 in *P. oregonensis*); also, there are fewer rows of scales passing over the back between occiput and dorsal fin in *P. grandis* (37 to 41, against 40 to 53 in *P. oregonensis*).

The number of rows of scales above the lateral line is usually 14 or 15. Frequently but 13 are present, while rarely as many as 16 or even 17 have been observed. The pharyngeal bones appear to show no characters distinctive of the species.

San Francisquito, Coyote, and Alameda creeks.

Measurements of 10 specimens of P. grandis from Alameda Creek, Sunol, Alameda County, Cal.[a]

Sex	Male.					Female.				
Length of body in millimeters	161	150	146	125	122	123	122	115	101	90
Length of head	.29	.275	.275	.275	.28	.285	.275	.285	.28	.29
Depth body	.215	.21	.19	.19	.21	.21	.20	.21	.20	.22
Snout to dorsal	.60	.58	.57	.57	.57	.58	.59	.59	.595	.58
Snout to ventral	.58	.56	.56	.55	.56	.57	.565	.565	.565	.57
Depth caudal peduncle	.09	.09	.09	.09	.09	.09	.09	.09	.09	.09
Length caudal peduncle	.175	.165	.16	.165	.16	.165	.175	.16	.16	.16
Length snout	.10	.10	.09	.095	.09	.095	.09	.10	.095	.10
Length maxillary	.115	.11	.11	.11	.11	.11	.11	.11	.11	.11
Diameter eye	.05	.05	.05	.05	.05	.05	.05	.05	.05	.05
Interorbital width	.08	.08	.08	.08	.08	.075	.08	.075	.08	.08
Depth head	.16	.155	.155	.15	.15	.16	.15	.15	.16	.16
Length base of dorsal	.11	.11	.11	.11	.105	.115	.10	.105	.105	.11
Height dorsal	.17	.18	.18	.18	.19	.19	.185	.19	.19	.20
Length base of anal	.09	.095	.09	.095	.095	.095	.09	.095	.09	.09
Height anal	.15	.165	.165	.16	.16	.16	.16	.165	.17	.18
Length pectoral	.17	.175	.17	.16	.16	.16	.155	.16	.17	.18
Length ventral	.135	.145	.14	.14	.14	.14	.14	.14	.14	.15
Length caudal	.265	.265	.27	.27	.27	.27	.25	.27	.27	.29
Dorsal rays	8	8	8	8	8	8	8	8	8	8
Anal rays	8	8	8	8	8	8	8	8	8	8
Scales lateral line	75	77	74	73	77	77	77	76	75	77
Scales above lateral line	13	14	14	13	14	14	14	14	15	15

[a] Expressed in hundredths of the length of the body measured from tip of snout to end of last vertebra.

7. **Leuciscus crassicauda** (Baird & Girard).

Coyote Creek.

8. **Rutilus symmetricus** (Baird & Girard).

San Francisquito, Madera, San Antonio, Campbell, Guadalupe, Coyote, Alameda, Arroyo Honda, and Isabel creeks. The apparent absence of this species from Stevens Creek is notable, as it occurs in smaller streams close by. It is able to maintain itself in Madera Creek during periods of drought, when nothing remains of the stream but a few small disconnected pools.

The species being generally distributed throughout the Sacramento basin and subject to considerable variation, measurements of a number of carefully preserved examples are here given:

Measurements of examples of Rutilus symmetricus from streams tributary to the southern arm of San Francisco Bay.

	Alameda Creek Basin.									
	Alameda Creek, Sunol.									
Sex	Male.					Female.				
Length of body	66	66	64	64	47	74	66	65	62	59
Length head	.26	.25	.25	.25	.25	.25	.26	.25	.26	.26
Depth body	.27	.27	.26	.255	.24	.245	.27	.26	.24	.25
Snout to dorsal	.58	.56	.56	.57	.57	.57	.57	.57	.58	.58
Snout to ventral	.53	.52	.52	.52	.52	.53	.54	.52	.53	.53
Depth caudal peduncle	.10	.115	.10	.10	.10	.095	.11	.10	.10	.10
Length caudal peduncle	.18	.18	.18	.19	.20	.18	.18	.175	.17	.19
Length snout	.09	.08	.08	.075	.08	.08	.09	.08	.08	.09
Length maxillary	.075	.08	.075	.07	.08	.075	.08	.08	.08	.08
Diameter eye	.06	.06	.06	.065	.07	.06	.065	.065	.065	.07
Interorbital width	.09	.09	.09	.09	.09	.09	.10	.09	.09	.09
Depth head	.185	.19	.19	.19	.19	.18	.20	.18	.19	.18
Length base of dorsal	.16	.15	.165	.16	.14	.145	.165	.15	.15	.15
Height dorsal	.23	.22	.19	.19	.22	.185	.215	.19	.19	.21
Length base of anal	.13	.125	.15	.115	.12	.10	.12	.12	.12	.12
Height anal	.21	.20	.19	.19	.20	.17	.19	.17	.18	.19
Length pectoral	.25	.24	.22	.23	.23	.20	.20	.19	.20	.19
Length ventral	.18	.17	.165	.16	.17	.16	.16	.14	.15	.16
Length caudal	.32	.32	.28	.29	.30	.30	.31	.29	.28	.29
Dorsal rays	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	10	8	8	8	8	8	8	8
Scales lateral line	56	61	61	60	60	59	55	60	60	58
Scales above lateral line	14	13	13	14	14	13	15	14	14	13

Measurements of examples of Rutilus symmetricus from streams tributary to the southern arm of San Francisco Bay.

	Alameda Creek Basin.																			
	Alameda Creek near Sunol.																			
Sex	Male.										Female.									
Length of body	62	65	65	60	58	59	57	57	55	52	66	70	64	63	63	63	57	60	62	60
Snout to dorsal	.56	.58	.59	.58	.55	.57	.57	.57	.56	.56	.57	.55	.55	.59	.59	.59	.58	.565	.59	.58
Snout to ventral	.52	......	.53	.52	.51	.53	.52	.51	.53	.51	.54	.52	.52	.55	.55	.53	.53	.54	.55	.52
Depth caudal peduncle	.11	.11	.10	.11	.11	.10	.10	.105	.10	.11	.10	.10	.10	.11	.105	.10	.105	.11	.105	.11
Length caudal peduncle	.21	.20	.18	.18	.20	.19	.19	.19	.18	.20	.19	.185	.165	.165	.17	.175	.20	.19	.20	.20
Length snout	.08	.08	.08	.08	.08	.08	.085	.08	.075	.085	.085	.075	.085	.08	.08	.08	.08	.08	.08	.08
Interorbital width	.085	.08	.085	.085	.08	.08	.085	.08	.08	.09	.09	.085	.09	.09	.09	.085	.09	.09	.09	.09
Height dorsal	.20	.21	.19	.21	.21	.21	.20	.215	.20	.21	.20	.20	.20	.20	.19	.19	.22	.20	.21	.20
Height anal	.20	.19	.19	.20	.19	.20	.19	.19	.20	.20	.18	.18	.19	.18	.18	.18	.19	.175	.17	.19
Length pectoral	.24	.225	.23	.22	.24	.24	.23	.23	.21	.25	.20	.185	.19	.19	.18	.18	.19	.20	.20	.20
Length ventral	.17	......	.18	.17	.17	.17	.17	.17	.16	.18	.165	.15	.15	.15	.14	.145	.16	.155	.16	.15
Length caudal	.32	.29	.29	.29	.31	.31	.31	.31	.29	.31	.30	.28	.31	.29	.30	.275	.29	.30	.30	......
Dorsal rays	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Scales lateral line	55	57	54	56	55	52	57	55	54	55	59	57	55	56	55	56	54	56	55	53
Scales above lateral line	13	13	13	14	14	13	13	14	14	13	14	13	14	14	14	13	13	14	14	13

Measurements of examples of Rutilus symmetricus from streams tributary to the southern arm of San Francisco Bay—Continued.

	Alameda Creek Basin.																													
	Isabel Creek.																													
Sex	Male.															Female.														
Length of body	72	66	66	65	63	65	61	75	67	62	65	60	58	59	60	76	76	65	65	62	72	73	63	63	65	65	64	62	59	63
Length head	.25	.25	.26	.26	.255	....	....	....	....	....	....	....	....	....	....	.25	.25	.26	.25	.26	....	....	....	....	....	....	....	....	....	....
Depth body	.25	.27	.26	.26	.27	....	....	....	....	....	....	....	....	....	....	.25	.26	.265	.25	.26	....	....	....	....	....	....	....	....	....	....
Snout to dorsal	.56	.59	.57	.575	.57	.58	.575	.57	.57	.58	.585	.59	.575	.575	.58	.58	.58	.57	.575	.58	.59	.57	.59	.58	.575	.57	.58	.59	.59	.58
Snout to ventral	.52	.53	.52	.52	.53	.52	.53	.52	.52	.53	.525	.525	.54	.53	.535	.52	.52	.55	.52	.53	.54	.53	.53	.54	.53	.53	.53	.53	.54	.53
Depth caudal peduncle	.11	.10	.105	.11	.105	.10	.10	.11	.10	.10	.10	.10	.105	.11	.10	.10	.10	.10	.105	.10	.10	.10	.11	.10	.11	.10	.11	.10	.10	.10
Length caudal peduncle	.22	.20	.20	.22	.22	.20	.20	.19	.195	.20	.20	.205	.19	.225	.21	.20	.20	.19	.21	.20	.19	.20	.19	.21	.20	.19	.20	.20	.20	.20
Length snout	.08	.08	.08	.08	.075	.07	.07	.08	.08	.08	.085	.075	.075	.08	.08	.075	.08	.08	.08	.08	.08	.08	.08	.075	.075	.08	.075	.07	.075	.08
Length maxillary	.08	.08	.08	.08	.08	....	....	....	....	....	....	....	....	....	....	.08	.08	.08	.08	.08	....	....	....	....	....	....	....	....	....	....
Diameter eye	.06	.06	.06	.06	.06	....	....	....	....	....	....	....	....	....	....	.05	.06	.06	.055	.06	....	....	....	....	....	....	....	....	....	....
Interorbital width	.08	.09	.09	.09	.08	.08	.08	.085	.08	.085	.08	.08	.08	.085	.085	.08	.085	.09	.09	.09	.09	.08	.08	.09	.085	.085	.08	.09	.08	.085
Depth head	.19	.19	.19	.19	.18	....	....	....	....	....	....	....	....	....	....	.18	.18	.19	.18	.19	....	....	....	....	....	....	....	....	....	....
Length base of dorsal	.11	.13	.14	.13	.125	....	....	....	....	....	....	....	....	....	....	.14	.14	.11	.13	.14	....	....	....	....	....	....	....	....	....	....
Height dorsal	.19	.19	.19	.19	.20	.20	.20	.19	.20	.19	.19	.21	.19	.20	.20	.19	.185	.19	.18	.19	.19	.17	.18	.19	.175	.18	.19	.20	.18	.18
Length base of anal	.11	.09	.10	.10	.09	....	....	....	....	....	....	....	....	....	....	.10	.10	.095	.10	.095	....	....	....	....	....	....	....	....	....	....
Height anal	.18	.18	.19	.17	.18	.19	.19	.18	.19	.185	.19	.18	.19	.18	.18	.17	.17	.17	.16	.17	.17	.145	.16	.17	.16	.16	.17	.18	.17	.165
Length pectoral	.21	.225	.22	.23	.24	.23	.22	.235	.23	.24	.23	.23	.24	.225	.24	.19	.18	.20	.17	.20	.195	.18	.19	.185	.185	.19	.19	.19	.19	.18
Length ventral	.165	.16	.16	.15	.16	.16	.155	.17	.15	.15	.165	.16	.15	.155	.15	.145	.14	.11	.13	.14	.14	.13	.14	.14	.135	.14	.11	.15	.15	.14
Length caudal	.27	.27	.26	.26	.27	.26	.275	.28	.265	.28	.26	.26	.275	.28	.28	.25	.25	.27	.25	.26	.26	.24	.25	.245	.24	.24	.27	.265	.27	.26
Dorsal rays	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Scales lateral line	57	59	57	59	57	57	58	57	56	60	56	56	57	56	58	51	57	58	58	57	56	60	58	56	55	57	55	59	55	54
Scales above lateral line	14	13	12	13	13	13	14	14	13	14	13	14	13	13	13	14	12	13	14	13	13	13	13	13	13	14	13	13	13	13

	Alameda Creek Basin.																								
	Arroyo Honda Creek.																								
Sex	Male.														Female.										
Length of body	68	68	66	66	62	65	65	66	67	64	60	63	58	62	73	71	67	66	66	66	66	65	62	63	60
Length head	.255	.25	.25	.26	.26	....	....	....	....	....	....	....	....	....	.255	.26	.26	.26	.26	....	....	....	....	....	....
Depth body	.275	.26	.26	.26	.26	....	....	....	....	....	....	....	....	....	.26	.27	.25	.27	.26	....	....	....	....	....	....
Snout to dorsal	.57	.565	.56	.57	.56	.57	.55	.57	.57	.57	.57	.56	.57	.58	.57	.59	.59	.59	.58	.57	.58	.58	.57	.59	.58
Snout to ventral	.52	.515	.52	.52	.52	.51	.51	.52	.52	.51	.525	.51	.53	.52	.525	.53	.52	.53	.53	.53	.52	.52	....	.53	.54
Depth caudal peduncle	.115	.11	.11	.115	.11	.11	.11	.11	.11	.11	.11	.11	.11	.11	.11	.11	.12	.11	.105	.11	.105	.11	.11	.105	.11
Length caudal peduncle	.20	.215	21	.19	.19	.18	.19	.20	.20	.20	.21	.21	.22	.20	.20	.19	.19	.19	.19	.19	.21	.20	.19	.19	.19
Length snout	.08	.08	.075	.08	.08	.075	.075	.08	.08	.08	.08	.08	.08	.08	.08	.08	.085	.08	.08	.08	.08	.08	.075	.085	.08
Length maxillary	.08	.08	.08	.08	.08	....	....	....	....	....	....	....	....	....	.08	.08	.08	.08	.08	....	....	....	....	....	....
Diameter eye	.06	.06	.06	.07	.065	....	....	....	....	....	....	....	....	....	.06	.065	.065	.065	.065	....	....	....	....	....	....

Interorbital width	.09	.09	.085	.09	.09	.08	.085	.08	.08	.08	.08	.08	.08	.08	.085	.09	.095	.09	.09	.09	.09	.085	.09	.085	.08
Depth head	.19	.18	.18	.19	.19	.....	.....	.....	.....	.....	.....	.....	.....	.....	.18	.19	.19	.19	.185	.....	.....	.....	.....	.....	.....
Length base of dorsal	.16	.15	.15	.145	.14	.....	.....	.....	.....	.....	.....	.....	.....	.....	.14	.14	.15	.15	.15	.....	.....	.....	.....	.....	.....
Height dorsal	.22	.20	.20	.21	.22	.20	.18	.19	.18	.19	.19	.19	.20	.20	.19	.18	.20	.20	.20	.19	.19	.18	.18	.19	.185
Length base of anal	.10	.11	.115	.10	.10	.....	.....	.....	.....	.....	.....	.....	.....	.....	.10	.10	.10	.105	.10	.....	.....	.....	.....	.....	.....
Height anal	.20	.18	.18	.19	.19	.20	.18	.18	.17	.18	.18	.18	.20	.19	.17	.18	.19	.18	.18	.18	.18	.18	.175	.18	.18
Length pectoral	.23	.22	.23	.23	.22	.23	.22	.225	.21	.23	.23	.23	.24	.22	.17	.18	.19	.19	.20	.19	.19	.20	.19	.20	.20
Length ventral	.17	.16	.165	.17	.17	.17	.16	.16	.16	.16	.16	.17	.16	.16	.13	.14	.16	.14	.14	.15	.145	.16	.....	.15	.14
Length caudal	.29	.27	.27	.28	.29	.27	.26	.28	.25	.27	.27	.26	.28	.27	.27	.27	.27	.27	.28	.27	.27	.27	.28	.26	.26
Dorsal rays	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Scales lateral line	54	60	55	59	55	59	55	58	55	55	55	57	54	54	58	61	54	56	55	55	59	56	54	60	57
Scales above lateral line	14	14	14	14	14	14	13	13	13	13	13	14	13	13	14	14	14	14	13	14	14	14	13	13	13

	Coyote Creek Basin.																			
	Coyote Creek.																			
Sex	Male.										Female.									
Length of body	66	61	62	63	61	56	60	61	58	59	69	67	70	71	69	64	70	63	67	61
Snout to dorsal	.56	.57	.55	.57	.57	.57	.55	.58	.57	.575	.58	.58	.58	.57	.58	.58	.565	.57	.585	.585
Snout to ventral	.52	.52	.51	.52	.52	.515	.51	.515	.52	.51	.52	.53	.52	.53	.525	.52	.515	.52	.52	.52
Depth caudal peduncle	.105	.105	.11	.105	.11	.105	.10	.10	.10	.11	.10	.105	.095	.095	.11	.10	.10	.10	.11	.10
Length caudal peduncle	.18	.19	.185	.17	.18	.20	.20	.20	.20	.19	.18	.19	.21	.18	.20	.17	.20	.19	.18	.20
Length snout	.075	.08	.08	.08	.08	.08	.08	.08	.08	.08	.085	.085	.09	.08	.09	.08	.085	.085	.08	.09
Interorbital width	.08	.08	.085	.08	.08	.08	.085	.085	.08	.055	.09	.085	.08	.09	.09	.085	.085	.09	.09	.08
Height dorsal	.19	.20	.20	.21	.21	.21	.21	.205	.215	.20	.195	.18	.19	.20	.20	.19	.185	.21	.19	.20
Height anal	.18	.19	.185	.19	.19	.20	.185	.175	.185	.18	.17	.165	.175	.17	.18	.17	.17	.18	.18	.18
Length pectoral	.20	.22	.22	.22	.235	.24	.21	.19	.21	.22	.19	.18	.17	.19	.19	.19	.19	.15	.195	.18
Length ventral	.15	.17	.16	.16	.18	.16	.16	.15	.155	.155	.15	.14	.15	.15	.145	.15	.14	.15	.16	.14
Length caudal	.27	.30	.29	.29	.30	.31	.30	.29	.28	.31	.27	.27	.28	.28	.28	.29	.....	.30	.30	.29
Dorsal rays	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Scales lateral line	55	55	59	58	50	51	54	55	52	53	60	58	55	59	56	57	53	55	60	51
Scales above lateral line	14	14	15	14	13	13	13	14	13	14	14	14	14	13	14	14	13	15	14	13

Measurements of examples of Rutilus symmetricus from streams tributary to the southern arm of San Francisco Bay—Continued.

	San Francisquito Creek Basin.															
	San Francisquito Creek.															
Sex	Male.										Female.					
Length of body	79	68	62	65	61	71	64	49	45	47	79	74	100	111	70	61
Snout to dorsal	—.55	.55	.58	.58	.56	.55	.56	.55	.56	.57	.58	.56	.56	.58	.57	60
Snout to ventral	.51	.52	.52	.52	.53	.50	.54	.51	.51	.51	.53	.52	.515	.51	.51	......
Depth caudal peduncle	.10	.105	.11	.10	.105	.10	.10	.10	.10	.10	.10	.10	.10	.10	.10	11
Length caudal peduncle	.19	.19	.19	.18	.20	.195	.20	.19	.20	.21	.18	.18	.20	.18	.19	175
Length snout	.085	.08	.08	.08	.08	.08	.08	.075	.08	.085	.08	.08	.085	.08	.08	.075
Interorbital width	.09	.09	.09	.09	.08	.08	.09	.09	.085	.08	.09	.085	.09	.08	.08	.08
Height dorsal	.21	.22	.21	.22	.23	.20	.21	.21	.22	.21	.20	.20	.20	.18	.195	.21
Height anal	.185	.215	.20	.20	.22	.19	.19	.20	.20	.20	.18	.19	.18	.165	.17	.18
Length pectoral	.24	.24	.24	.24	.24	.225	.21	.23	.24	.24	.20	.20	.195	.18	.19	.21
Length ventral	.17	.18	.185	.18	.17	.16	.17	.17	.17	.175	.15	.15	.155	.14	.16	......
Length caudal	.28	.28	.29	.29	.30	.28	.30	.28	.30	.29	.29	.265	.27	.295	.26	.30
Dorsal rays	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
Anal rays	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
Scales lateral line	57	56	60	59	57	59	54	56	58	58	59	59	60	54	59	57
Scales above lateral line	13	13	13	13	13	14	14	12	13	12	14	13	13	12	13	13

9. **Agosia nubila carringtoni** (Cope).

Coyote, Arroyo Honda, and Isabel creeks.

10. **Salmo irideus** Gibbons.

San Francisquito, Madera, San Antonio, Stevens, Campbell, Guadalupe, Coyote, Arroyo Honda, Smith, and Isabel creeks.

11. **Gasterosteus cataphractus** (Pallas).

San Francisquito, Madera, San Antonio, Stevens, Guadalupe, and Coyote creeks. Often seen in brackish ponds and sloughs near the bay.

12. **Hysterocarpus traski** Gibbons.

Coyote and Alameda creeks.

13. **Cottus asper** Richardson.

Recent authors have identified the common Sacramento form which represents the *Cottus asper* [a] of the Columbia River with the *Cottopsis gulosus* [b] of Girard. They have sometimes considered the Sacramento form as identical with *C. asper* and have placed the name *gulosus* in the synonymy of the latter. At other times they have considered the species as a slightly differentiated form worthy of recognition in nomenclature, and have used the name *gulosus* to designate it. The former view concerning the species is probably correct. The association of the name *gulosus* with it, however, is without warrant. The latter belongs to a species easily distinguished from *C. asper*, differing notably in having a much shorter anal fin. There are usually fewer dorsal spines and rays, a more limited distribution of prickles, and an almost uniform absence of palatine teeth. In *C. asper* the dorsal has 8 to 10 spines and 19 to 22 articulated rays, the anal 16 to 18 rays, while in *C. gulosus* the dorsal has 7 to 9 spines, 17 to 18 rays, the anal 12 to 14 rays.

As a result of its having been confused with *C. asper*. *C. gulosus* was lately redescribed from the Sacramento Basin under the name *Cottus shasta* [c]. The types of the latter differ in no way from *C. gulosus* as described by Girard.

In its distribution *C. asper* appears to be largely confined to the lower courses of the streams, being especially abundant near tide water, while *C. gulosus* is found farther up, where the water is clear and the current rapid. The latter species has not been found in any of the creeks tributary to San Francisco Bay. *C. asper* is probably common to all of them.

Specimens have been observed in the following creeks: San Francisquito, Madera, San Antonio, Guadalupe, Coyote, and Alameda.

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[a] *Cottus asper*, Richardson, Fauna Bor.-Amer., Fish., 295, 1836.

[b] *Cottopsis gulosus* Girard, Proceedings Academy Natural Science Philadelphia, VII, 1854, 129.

[c] *Cottus shasta* Jordan and Starks, Proceedings California Academy of Science, VI, 1896, 224.

Fin counts of 34 specimens of C. asper from San Francisquito Creek.

Dorsal spines.	Dorsal rays.	Anal rays.	Pectoral rays.	Dorsal spines.	Dorsal rays.	Anal rays.	Pectoral rays.	Dorsal spines.	Dorsal rays.	Anal rays.	Pectoral rays.	Dorsal spines.	Dorsal rays.	Anal rays.	Pectoral rays.
8	20	17	18	8	19	16	16	8	20	16	16	8	20	17	15
9	20	16	15	9	19	17	18	8	20	17	16	9	19	15	16
9	19	17	16	8	19	16	16	8	19	16	17	8	20	16	16
8	19	16	16	8	20	17	16	8	20	16	16	8	18	16	16
8	20	17	16	9	20	16	16	8	20	17	17	8	19	16	16
8	21	17	16	8	21	17	17	9	19	17	16	9	19	16	15
9	22	18	16	9	21	17	16	8	20	16	16	8	19	16	16
8	21	16	17	8	20	16	16	8	19	16	16				
8	20	16	16	9	20	16	15	9	20	16	16				

Table showing distribution of species.

	San Francisquito Creek.	Madera Creek.	San Antonio Creek.	Stevens Creek.	Campbell Creek.	Gaudalupe Creek.	Coyote Creek, near mouth.	Coyote Creek, near San Jose.	Alameda Creek.	Arroyo Honda Creek.	Smith Creek.	Isabel Creek.
Entosphenus tridentatus	....	....	....	....	....	....	*	....	....	....	....	....
Catostomus occidentalis Ayres	*	*	*	*	*	*	*	*	*	*	*	*
Orthodon microlepidotus (Ayres)	....	....	....	....	....	....	*	*	....	....	....	....
Lavinia exilicauda Baird and Girard	....	....	....	....	....	....	*	*	*	....	....	....
Pogonichthys macrolepidotus (Ayres)	....	....	....	....	....	....	*	....	....	....	....	....
Ptychocheilus grandis (Ayres)	*	....	....	....	....	....	*	*	*	....	....	....
Leuciscus crassicauda (Baird and Girard)	....	....	....	....	....	....	*	....	....	....	....	....
Rutilus symmetricus (Baird and Girard)	*	*	*	....	*	*	*	*	*	*	....	*
Agosia nubila carringtoni (Cope)	....	....	....	....	....	....	*	....	....	*	....	*
Salmo irideus Gibbons	*	*	*	*	*	*	*	*	....	*	*	*
Gasterosteus cataphractus (Pallas)	*	*	*	*	....	*	*	....	....	....	....	....
Hysterocarpus traski Gibbons	....	....	....	....	....	....	*	*	*	....	....	....
Cottus asper Richardson	*	*	*	....	....	*	*	*	*	....	....	....

CRITICAL NOTES ON MYLOCHEILUS LATERALIS AND LEUCISCUS CAURINUS

By JOHN OTTERBEIN SNYDER
Assistant Professor of Zoology, Leland Stanford Junior University

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Girard[a], in 1856, placed *Leuciscus caurinus* Richardson[b] in the genus *Mylocheilus* along with *M. lateralis* Agassiz & Pickering[c] and *M. fraterculus*, which he described from Monterey, Cal. *Mylocheilus* has not been found in California by recent collectors, nor is there any stream near Monterey containing fresh-water fishes. The specimens alleged to have been taken there were probably from the north, and *M. fraterculus* has long been identified, no doubt correctly, with the form found in the Columbia River.

Recent authors have not only continued to associate *M. lateralis* with *L. caurinus*, but they have also considered the species identical, a proceeding wholly at variance with the facts. Richardson described a form closely resembling *Ptychocheilus oregonensis*, with which he says it was confused by the collector. He also observes[d] that *P. oregonensis* is so similar in general appearance to this species that it may readily be confounded with it. However, a comparison of the original descriptions of *M. lateralis* and *L. caurinus* will leave no doubt as to the distinctness of these two forms. Aside from the pharyngeal teeth, which Richardson does not mention, his species differs from *M. lateralis* in the absence of a maxillary barbel[e], in having 10 dorsal and 9 anal rays, a longer snout and larger mouth, scales suborbicular in shape, and other less conspicuous characteristics. The *Mylocheilus caurinus* of recent authors is synonymous with *M. lateralis* Agassiz & Pickering.

While conducting explorations in Oregon under the direction of the United States Bureau of Fisheries the writer secured a specimen from the Willamette River, near Corvallis, which agrees almost perfectly

[a] Girard, Charles, Proc. Ac. Nat. Sci. Phila., 1856, 169. Girard probably had specimens of *M. lateralis* which, on account of some slight individual variations, he identified as *L. caurinus*. He certainly did not have examples of the latter species as it is without barbels.

[b] Richardson, John, Fauna Boreali-Americana, III, 304, 1836.

[c] Agassiz, L., Am. Jour. Sci. Arts, XIX, 1855, 231.

[d] Richardson, op. cit., p. 305.

[e] Richardson, op. cit., p. 120. "The *Leucisci*, or Daces, have a short dorsal and anal, are destitute of spinous rays or barbels, and exhibit nothing peculiar in the structure of their lips."

with the original description of *Leuciscus caurinus* and without doubt belongs to that species, an example of which has not previously been seen by any observer since Richardson's time. Superficially, *L. caurinus* resembles *Ptychocheilus oregonensis*, as was pointed out by Richardson, and as if to confirm that observation the specimen in hand was taken along with many individuals of the latter species, its identity not being discovered in the field. The specimen is here described in dètail.

Head 4 in length to base of caudal; depth 4.6; depth of caudal peduncle 3 in head; length of snout 2.9; maxillary 3.1; diameter of eye 5.6; width of interorbital space 2.9; dorsal rays 10; anal 9; scales in lateral line 86.

Body elongate, the width contained about 1.5 times in the depth; head long, the snout prominent; mouth large, end of maxillary reaching a vertical passing midway between anterior edge of orbit and pupil, upper lip without frenum; lower jaw included, its edge being posterior to tip of snout a distance equal to three-fourths the diameter of pupil; maxillary without barbel; distance between nostril and eye equal to half the diameter of eye; eye located nearer tip of snout than edge of opercle, a distance equal to its diameter; gillrakers on first arch 9 or 10, short, pointed; pharyngeal teeth in two series, 2+4 on the right arch, 1+5 on the left; the lesser teeth slender and round, their tips curved away from the others; greater teeth considerably flattened, hooked at their tips, with a narrow though distinct grinding surface which is more pronounced on the middle teeth than on the outer ones. Peritoneum dusky. Exposed edges of scales semicircular; scales of breast and throat minute, those on back anterior to dorsal fin small, becoming minute and closely crowded on the nape; scales in series above lateral line 21, between dorsal and occiput about 59; lateral line complete, decurved in the region above pectoral fin; origin of dorsal fin midway between anterior edge of pupil and base of caudal, second fully developed ray longest, the last ray reaching slightly beyond it when the fin is depressed; free edge of fin slightly concave; origin of anal slightly behind base of last dorsal ray, first and last rays reaching an equal distance posteriorly when fin is depressed; posterior edge of fin slightly concave; caudal deeply notched; origin of ventrals about a pupil's diameter in advance of dorsal; tips of fins just reaching anal opening; pectorals obtusely pointed. Color plain, dusky above, light below.

The following measurements are expressed in hundredths of the length to base of caudal, which is 227 millimeters: Head 0.25; depth 0.22; snout to dorsal 0.56; snout to ventrals 0.525; depth of caudal peduncle 0.08; length of snout 0.09; maxillary 0.085; diameter of eye 0.045; interorbital width 0.085; depth of head 0.16; length of base of dorsal 0.13; longest dorsal ray 0.175; base of anal 0.11; anal ray 0.155; length of pectoral 0.18; ventral 0.155; caudal 0.27.

THE GAS DISEASE IN FISHES

By M. C. MARSH
Assistant, Bureau of Fisheries

AND

F. P. GORHAM
Associate Professor of Biology, Brown University

CONTENTS.

THE GAS DISEASE IN FISHES.

By M. C. Marsh, *Assistant, Bureau of Fisheries*, and F. P. Gorham, *Associate Professor of Biology, Brown University.*

INTRODUCTION.

The pathologic symptoms and changes which affect fishes and some other aquatic animals, and are here grouped as a unity under the general term "gas disease", do not include all abnormal manifestations of gas or symptoms involving gas. In the literature of the pathology of the lower animals gas disease does not appear to be recognized definitively, though some of the numerous references to gaseous symptoms, and particularly to the so-called "pop-eye" in fishes, doubtless apply to the disease as here discussed and limited. In cattle and other mammals certain bacterial diseases are accompanied by evolution of gas within the tissues.

The gas disease of aquatic animals was first observed and recognized among fishes in sea water at the station of the Bureau of Fisheries at Woods Hole, Mass. It has been observed also at other stations, at the New York Aquarium, and among fresh-water fishes, and it has without much doubt occurred at private establishments. At Woods Hole it is known to have progressed for several years.

In general terms the cause of the gas disease lies in the relation of the amount of air dissolved in the water in which the affected fishes live to temperature and pressure. An understanding of this relation will follow a consideration of the laws of solubility of gases in water and particularly of the gases which constitute the atmosphere.

SOLUBILITY OF GASES IN WATER.

The amount of a given gas which pure water will dissolve depends upon temperature and pressure and upon the solubility of the gas. Under increased pressure the capacity of water for holding any gas is increased, while at an increased temperature this capacity is diminished. The coefficient of solubility varies widely for the different gases. Oxygen and nitrogen, which chiefly make up the atmosphere, are but slightly soluble in water, while carbon dioxid, which con-

tributes a very small part to the total atmospheric bulk, is extremely soluble.

Ignoring its minor constituents and regarding the argon group of gases with the nitrogen, the atmosphere is approximately made up of 79 parts of nitrogen gas and 21 parts of oxygen gas by volume. The carbon dioxid present has no particular connection with the gas disease and will not be referred to further. When water is exposed to the atmosphere it absorbs these two gases until a state of equilibrium is reached, when no further change takes place and these gases, if the temperature and pressure remain constant, are neither further absorbed nor given off by the water. The latter is then said to be saturated with air. If now any change takes place in the temperature of the water, or in the pressure which it sustains, either a further absorption will occur or some of the air will be given off from the water. These changes, especially under artificial conditions, may occur rapidly, and the adjustment to an equilibrium may not keep pace; therefore, at any given time water may fall short of saturation and air be passing into it, or it may be supersaturated and air be passing away from it, assuming of course in either case that it is not protected from contact with the atmosphere. In other words, water may hold in solution an excess or a deficiency of air, or an excess or deficiency of either one of the air gases, nitrogen or oxygen, independently of the other. The rapidity with which water supersaturated or infrasaturated with air will become saturated, or in equilibrium, will depend upon the area of its contact with the atmosphere. It therefore follows that water only moderately exposed to the atmosphere, as in tanks or most containers, may remain for a considerable time either above or below the saturation point. But the tendency is constantly toward the equilibrium of the saturation point, which will always finally be reached.

The actual amounts of nitrogen and of oxygen which water will absorb from the atmosphere have been determined by analyses of air-saturated water. Authorities differ somewhat in the results. The figures cited here and in the tables give the highest values. One liter of pure water at 0° C., the freezing point, and at a pressure of 760 mm. of mercury, the standard atmospheric pressure, will absorb 19.53 c. c. of nitrogen from the atmosphere (Pettersson and Sonden) and 10.18 c. c. of oxygen (Winkler); at 20° C. and 760 mm., 12.8 c. c. nitrogen (Dittmar), and 6.35 c. c. of oxygen (Winkler). Pure sea water takes up somewhat less. These figures are taken from Comey's Dictionary of Solubilities.

RESPIRATORY PROCESSES AND MECHANISM IN FISHES.

To understand the effect of supersaturated water upon fishes it is necessary to consider the respiratory processes and the mechanism by

which a dissolved gas could gain access to their circulation. In warm-blooded animals the life processes depend upon the absorption of oxygen by the tissues and the elimination of carbon dioxid, and this interchange is effected through the medium of the blood. The liquid portion of the blood, the plasma, carries but a small portion of the total oxygen dissolved in the blood. This portion is in amount about what an equivalent volume of water would absorb, and is held in simple solution, as in water (Foster, 1895, p. 588). Most of the oxygen of the blood is carried by the red corpuscles, which are vehicles for this gas by virtue of the hemoglobin they contain, with which oxygen readily combines and from which it may readily be separated. The tissues of the body have a stronger affinity for the oxygen than that which exists between the hemoglobin and the oxygen, and they therefore take the oxygen from the hemoglobin of the corpuscle, and give in return carbonic acid, not to the corpuscle, but to the plasma of the blood. When the blood next reaches the lungs it gives up this carbonic acid to the external air, while the hemoglobin of the corpuscle takes up a new supply of oxygen from the air. Though the blood does not come into direct contact with the atmosphere, the corpuscles come into intimate relation with it and are separated from it only by a thin layer of epithelial cells, constituting the final subdivision of the lung. Through this membranous partition the interchange of gases takes place by diffusion, the process being known as osmosis, and the permeable membrane as an osmotic membrane. Osmosis is governed by laws analogous to those of simple diffusion of gases, or of the absorption of gases by liquids, and depends therefore in part on the pressure exerted by each gas concerned. The blood side of the membrane is high in carbon dioxid and low in oxygen, while the air side is high in oxygen and low in carbon dioxid. Each gas exerts its pressure independently of the other, the carbon dioxid to pass out toward the air, the oxygen to pass in toward the blood. The tendency is to equalize each gas on the two sides of the membrane, when the pressure on both sides would be equal and osmosis would cease. Since in life this can never occur, because the carbon dioxid going out is continuously produced within and the oxygen coming in is continuously used up within, there is a continuous stream of these two gases passing in different directions, and at an osmotic pressure which does not vary greatly under usual conditions. Any increase of the proportion of oxygen in the atmosphere, or any increase of barometric pressure, would increase the osmotic pressure and more rapidly force the oxygen into the blood. The workman in the compressed-air caisson labors under a high osmotic pressure, which may seriously affect the respiratory process.

The nitrogen of the air is normally taken up by the blood in amounts insignificant as compared with the oxygen, and is held in simple

solution, probably in the plasma alone. One hundred volumes of arterial blood hold some twenty volumes of oxygen, but only from one to two volumes of nitrogen (Foster, 1895, pp. 586, 601).

The physiology of respiration in cold-blooded animals is not so completely known, but the broad facts cited above apply equally to fishes. There is the interchange of oxygen and carbon dioxid, the corpuscle with hemoglobin as the carrier of the oxygen and a set of vascular filaments fulfilling the same office as the lungs. The gills are immersed in water instead of air, but this does not greatly alter the nature of the breathing process. The blood merely gives up carbon dioxid to and takes up oxygen from a solution of these gases in water instead of directly to and from an atmosphere which they partially constitute. The epithelium of the gill filament is the osmotic membrane, and in this case the osmotic pressure of the oxygen and of the nitrogen depends upon the amount of these gases in solution in the water and not directly on the atmospheric pressure, though the latter has an influence on the amount of air dissolved in the water. The nitrogen is not known to play any part in respiration and the plasma probably remains with a fairly constant quota of this gas corresponding to the amount of nitrogen dissolved in the water, which is usually air-saturated with it. In water recently boiled and containing scarcely any oxygen the osmotic pressure due to oxygen is practically nothing, and in this fishes suffocate. The highest osmotic pressure under ordinary conditions experienced by fishes occurs when water at the freezing point—or slightly colder, since salt-water fishes can live in water below 0° C.—is so well aerated that it has dissolved all the air it will hold at whatever atmospheric pressure exists. Of fishes in higher osmotic pressures than this no cases are known to the writers save those here described, and experimental observations under such conditions seem not to have been made.

SYMPTOMS AND LESIONS OF THE GAS DISEASE IN FISHES.

The occurrence in fishes of lesions of a gaseous nature is no recent observation. A certain exophthalmia known in fish-cultural parlance as "pop-eye" has long been recognized and is due in many cases to the presence of a gas either behind the eyeball or within it. This may be accompanied by inflations of the mucous membrane lining the mouth cavity or of the skin elsewhere, and these lesions may exist independently of the so-called pop-eye. At the Woods Hole station of the Bureau of Fisheries these symptoms have been observed during the summer for years among marine fishes held in aquaria for purposes of exhibition, and have been described by Gorham (1899). In very cold water at the same place, other conditions remaining the same, the course of the disease is more rapid and the symptoms somewhat different. In aquaria of sea water a few degrees above the

freezing point fishes show within some three minutes after their introduction a reaction consisting of extremely minute and very close-set gas bubbles. Within about ten minutes the bubbles visibly increase in size and become much more conspicuous, enveloping the fish completely, body and fins, in a delicate, shimmering layer of silvery white. It is evident that the bubbles do not emanate from the fish itself, although they appear to; almost any surface within the water, as that of rocks and the sides of the aquarium, exhibits the same phenomenon. Neither are they free bubbles afloat in the water which happen to attach themselves by contact to the bodies of fishes—though this may occur and simulate, in any water, the appearance under discussion—because the same occurrence takes place after all free bubbles have been allowed to rise and escape and fish are immersed in perfectly clear and quiet water. The gas is a precipitate from the water itself, in which it must have been in solution. At first, while the bubbles are very small, they are quite closely adherent and the fish may execute rapid movements without dislodging them. As they grow larger they detach themselves readily and rise to dissipate at the surface. A sudden movement will release a cloud of hundreds or thousands of bubbles. A few seconds' removal of the fish from the water will completely dissipate all the bubbles, but after its return to the water they are soon formed again in their usual abundance. In fact, these bubbles are more or less a feature of all the fishes as long as the latter remain in water of this quality.

The gas in the tissues, which manifests itself in blebs of the greatest diversity in size and location, does not appear immediately, but only after several hours at the earliest. The blebs may arise at any point, the favorite seats being the fins and the head (fig. 1, pl. I). This lesion consists merely of a local accumulation of gas in or beneath the skin, the outer layer of which is often stretched to an attenuated thinness by the expansive pressure. If the so-called "slime" of the skin is abundant, bubbles may form within it, in which case they are small and numerous. The tautog has an abundance of this slime and presents a characteristic picture after a reaction of several hours. The bubbles tend to buoy the slime and tear it from the body; it is partly separated in long streamers, which remain attached at one end while they float suspended in the water, buoyed by the bubbles which cling to the surface and are embedded within the substance. This fish takes on, after about an hour, a strikingly ragged and tattered appearance, which is shown by no other species save the cunner. In fact, each species exhibits the external gaseous lesions in a way more or less peculiar to itself. The tomcod is especially prone to develop a few extraordinarily large vesicles of gas in its fin membrane. The buoyant action of these is often considerable, and when they are present in the caudal or last dorsals they tilt the fish out of position and require a constant effort to

overcome their effects. The tautog, besides the appearances cited, has almost invariably small elongate blebs between the rays of the pectoral and usually also the caudal fin. The small sculpin (*Myoxocephalus æneus*) seldom fails to develop in the skin of the belly an emphysema of a honeycomb structure; and often in the later stages, by coalescence or enlargement, vesicles containing several cubic centimeters of gas may form, floating the fish belly upward long before it finally succumbs.

Very young puffers (*Spheroides maculatus*, fig. 1, pl. II), when only half an inch long, develop vesicles at the base of the caudal fin sometimes as large as the entire body of the fish, which buoy it to the surface and keep it there in spite of its struggles to descend. The pipe-fish (*Siphostoma fuscum*) usually shows vesicles about the snout. In the scup (*Stenotomus chrysops*), both large and small (2-inch), the first indication of the presence of gas is seen in the protrusion of the eyeballs, bringing about the condition known as pop-eye.

These external lesions, however, though interesting and important in their bearing on the explanation of the disease, are not sufficient to cause death. Aside from some occasional bloody streaks in the fins, eyes, or muscles, neither constant nor characteristic, no external lesions other than these are to be found and no adequate cause of death is to be seen. It is on laying open the dead or dying specimens that the fatal lesion is disclosed. A remarkable and striking picture presents. The blood vessels contain notable quantities of free gas, the amounts varying greatly, from a few small bubbles scattered through the larger vessels to a quantity which may distend the bulbus of the heart even to several times its normal bulk, stretching its walls to a thin membrane, tense and firm with the pressure of the gas contained to the entire exclusion of the blood, the whole resembling the air bladder of a small fish. The auricle may be still beating without propelling any blood. The fish may live for some time, probably for days, even after considerable quantities of gas have separated; for upon killing and opening scup not yet in the death struggle the gas has been plainly discerned. The walls of the auricle and ventricle may be emphysematous. The branchial artery or ventral aorta is often empty of blood and tense with the pressure of gas, while in the gills is found perhaps the most constant and significant lesion. The main vessel of the gill filament usually has its lumen filled with gas (fig. 2, pl. I), which is often seen just entering the capillaries that branch from this vessel. But these capillaries it seldom fills. The gas plugs of the gill filaments are usually present—though not always—even when the evidences of gas within the body are not very marked. A fatal embolism results, and death is due to stasis.[a] When nearly all the filaments are

[a] In these typical cases of embolized gill filaments and of a distended heart, no assumption of any form of initial cardiac paralysis seems necessary. The stasis must have occurred in spite of cardiac effort.

well filled with gas the condition modifies considerably the macroscopic appearance of the gill, and in fishes of some size the individual emboli may be seen on careful inspection by the naked eye.

The gas has not been observed in the capillaries of the body, but is confined to the larger vessels of the systemic circulation and the gills. It does not distend the veins, though bubbles may be seen in them. In sculpins in full roe the arteries ramifying over the surface of the ovary attract immediate attention by their appearance as pale bloodless streaks in contrast with the green background of the ovary and the dark red of the veins which accompany them. Gas bubbles may be seen in the pyloric cœca, in the walls of the intestine, and also within the intestine itself, though these latter may be due to other causes.

CAUSE OF THE GAS DISEASE IN FISHES.

POSSIBILITY OF INFECTION BY GAS-PRODUCING BACTERIA.

The inference to which all the gas symptoms at first give rise, of infection with gas-producing species of bacteria, has been negatived by repeated attempts to obtain cultures from the blood and tissues of affected fishes, among both the Woods Hole marine forms and those of fresh water. The microscope gives no evidence of infection, and inoculated culture media remain sterile. The Woods Hole sea water suffered no unusual pollution and the bacterial count at the intake in January and February averaged only 191 per cubic centimeter. The rapidity of the pathologic process, furthermore, contraindicates infection.

ABNORMAL GAS CONTENT OF WATER IN WHICH THE DISEASE OCCURS.

The sea water in which fishes die with these described lesions always has an extraordinary gaseous content. At the Woods Hole station it had passed through a pumping plant which elevated it to storage tanks to provide a gravity flow for aquarium and hatching purposes. Steam pumps took the water from the sea through a long suction pipe and forced it to a height of about 18 feet into tanks, from which it flowed to the aquaria and hatching boxes. At the point of intake the sea water was of normal quality and fishes lived in it without unusual symptoms. The suction pipe was of wood, had been long in use, and by deterioration had developed areas of porosity or open leaks, so that air continually gained access to the pipe and could readily be demonstrated at the pump, which forced a mixture of water and large quantities of air bubbles instead of a solid body of water. Immediately upon passing the pump this air and water came into a region of about 8 pounds hydrostatic pressure in addition to that of the atmosphere, and continued under this pressure through a long stretch of level water main. As the sea water was approximately saturated with

air at the intake it inevitably acquired a supersaturation on its journey from the pump to the storage tanks, due to the presence of air and the increase of pressure. In the storage tanks there was but slight exposure to the atmosphere and from them the water reached the aquaria containing its excess of air. In the aquarium tanks the water gives some evidence of its unusual condition in the form of precipitated bubbles of gas which gather on all solid surfaces in contact with the water, and in a minute effervescence which is barely visible when its perfectly smooth, unbroken surface is carefully observed. The actual effect of the release of these bubbles is to diminish but inappreciably the degree of excess while the flow is continuous, for the constant inflow is bringing new supplies of the supersaturated water.

Influence on respiration of fishes.—The gill apparatus of fishes, for the osmotic interchange of gases which keeps the blood purified, is presumably adjusted to water the gases of which were dissolved at atmospheric pressure. The gills of any fishes in this aquarium water are therefore subjected to an osmotic pressure higher than any to which they were habituated in nature. Osmosis is accelerated and the blood takes up unusual quantities of air. The goal toward which the process tends is the same degree of supersaturation on one side of the gill membrane as on the other. In other words, the osmotic pressure on the two sides tends to equalize, and, inasmuch as blood and water have approximately the same saturation point, the blood stream tends to acquire the same excess of air as the water, or to become actually supersaturated with air. This is believed to be what actually takes place. The circulation becomes supersaturated.

In cases where fishes are brought up from considerable depths and confined in this water, the great reduction of pressure acting on the gas in the air-bladder and tissues permits the expansion of this gas. There is an attempt on the part of the fish to remove this excess gas, first by absorption into the blood and second by osmosis through the gills. But the second part of the process is inhibited by the already high gas content of the water in which the fish are placed. Thus in these fishes the supersaturation of the blood is more readily brought about.

The subsequent release of gas within the vessels is to be explained chiefly by temperature changes within the blood. While fishes are cold-blooded animals, their body temperature is not exactly uniform with that of the surrounding medium. The combustion involved in the life processes implies the evolution of heat, and this heat is appreciable and has been measured. The venous circulation shows the highest temperature, and in fishes of several common marine species has been found to be from 2° to 12° F. warmer than the surrounding water (J. H. Kidder, 1879). Between the gills and the systemic veins, then, the blood undergoes a greater or less elevation of temper-

ature, for in its course through the gills it must be cooled to or nearly to the temperature of the water. Its stream is too thin and it is too intimately exposed to the water to maintain an appreciably higher temperature. The blood, then, before it can return a second time to the gills, undergoes a rise in temperature, and as the solvent power of liquids decreases with increase of temperature, this rise tends toward the release in gaseous form of some of the dissolved air. No doubt the amount released is small per unit of time, but the free gas can not be reabsorbed and the process of release is continuous, so that a fatal embolism is only a question of time.

This seems a fairly satisfactory explanation of the means by which the gas arrives free within the blood vessels. It requires the assumption that in water of normal condition with respect to dissolved air the blood of fishes does not become completely saturated in the gills—else gas would be thrown out constantly by the higher temperature of the systemic circulation, which is of course contrary to fact. There is experimental proof that in mammals ordinary respiration does not saturate the blood—that is, that all the oxygen which it is capable of holding under the conditions does not enter it (L. Fredericq, 1896; O. Hammarsten, 1901, 531). That the observation holds good for fishes is extremely probable. It must further be assumed that under the conditions of supersaturation existing in the Woods Hole water the blood does take up all the air it will hold at its temperature in the gills; or, if it falls short of this, that it takes up more than it can hold at the maximum temperature to be encountered in its circulation through the body. This latter supposition is the more probable and, while no determinations support it, it is thoroughly in accord with the facts and may be provisionally accepted.

Temperature is not the sole cause which may play a part in the precipitation of the gas. For the separation of the solute, or dissolved substance, from a supersaturated solvent, there must be a nucleus about which the precipitating dissolved particles may gather—an excitant to start the process of precipitation. This is strikingly illustrated by supersaturated solutions of certain salts. A crystal of the same salt as that dissolved when introduced into such a solution will cause the immediate separation of this salt, which gathers about the crystal as a nucleus. Likewise water may be heated, in a perfectly clean and smooth flask, above the boiling point without ebullition. If a solid foreign particle, such as a fragment of pumice stone, be dropped into the flask, boiling instantly begins. To apply this principle to the present case, the minute floating corpuscles may be considered as the nuclei for the separation of gas from blood, which is supersaturated with it. The difference in temperature is the more important and fundamental cause of the release of gas, while doubtless the corpuscles at least provide *loci* for the change of state.

The time required for a fatal result depends primarily on the degree of excess. Death has been observed within three hours after introduction of a healthy fish into the abnormal water, but in this case the exact excess is unknown, and there was no autopsy. At 10° C. and an excess of 6 c. c. of nitrogen and 2 c. c. of oxygen per liter, a hake was killed at the end of 8 hours, and embolic gas under pressure in the heart was observed immediately after death. Ten hours frequently suffices for this result. Species differ in susceptibility.

Identity of gas in the blood vessels, external vesicles, and water.—Some relation of identity or source between the several gases within the blood vessels, in the external blebs, and that which separates directly from the water upon the fishes is at once inferred as probable, and the gas of all the lesions would seem to be derived from the water. The following four samples were determined by the United States Bureau of Chemistry, the first three collected in February. The merely adherent bubbles which formed on the exterior of the fishes had the following composition:

	Per cent.
Carbon dioxid	1.03
Oxygen	17.58
Nitrogen	81.39

A sample precipitated upon blocks of wood, no fishes being in the water, consisted of:

	Per cent.
Carbon dioxid	0.58
Oxygen	22.87
Nitrogen	76.55

The difference between the carbon dioxid and oxygen in these two samples should be referred to the respiration of the fishes, present in the first case and absent in the second. The gas from the large vesicles on the belly of the small sculpin (*Myoxocephalus aeneus*) was as follows:

	Per cent.
Carbon dioxid	3.78
Oxygen	18.09
Nitrogen	78.13

In this the oxygen is diminished and the carbon dioxid increased by oxidation of organic matter in the tissues. Methane, hydrogen, or carbon monoxid were not present in any of these samples.

A sample collected in September from the water alone showed:

	Per cent.
Carbon dioxid	0.4
Oxygen	20.6
Nitrogen	79.0

The gas is evidently nothing more than the constituents of air, the proportions varying more or less from those of the atmosphere.

The quantities actually dissolved in the water were first determined from a sealed and transported sample taken in September during the progress of the disease. The results are probably not perfectly accurate, because of the age of the sample. By reference to Table III, page 373, it is seen that this water had an excess of nitrogen of 2.2 c. c. per liter, and was a little less than saturated with oxygen. The time which elapsed between the taking and the determination of the sample, however, probably removed oxygen by oxidation, and there may have been an original excess of this gas as well as nitrogen.

Elimination of the disease by reducing gas content of water.—The replacement of the old suction pipe with a new impervious one abolished all signs of the gas disease at Woods Hole. Determinations made upon the water of the aquarium after air had been intentionally admitted to this new suction pipe showed definite and considerable excesses of both nitrogen and oxygen, these determinations being made at the station upon freshly taken samples. The gas was boiled from the water by the Tiemann and Preusse modification of Reichardt's apparatus (Hempel, 1902, p. 10) and determined by absorption, the residue after removal of carbon dioxid and oxygen being considered as nitrogen. There appeared an excess of both nitrogen and oxygen of some 3 to 6 c. c. per liter of water in the case of nitrogen, and of 1.5 to 2.5 c. c. of oxygen. This condition of the water killed 6 hake in from 8 to 20 hours. The figures are probably somewhat greater than those for the conditions of the old leaking suction pipe, which may be represented by an excess of about 2 c. c. of nitrogen per liter, and of somewhat less than 1 c. c. of oxygen. The water under the experimental conditions referred to with the new suction pipe had exactly the same effect upon fishes as the water during the service of the pervious wooden suction pipe, save that it was more rapidly fatal. The dead fishes showed all the described lesions and symptoms. It is left beyond question that the gases of the pure atmosphere are one of the efficient factors in the causation of the gas disease.

Exposure of the water to the atmosphere at atmospheric pressure removes the excess of air with a rapidity dependent on the degree of this exposure. Whenever by the mechanical arrangement of the delivery pipes at the aquaria the inflow of water was exposed, as when a strong jet was allowed to impinge upon the surface of the aquarium level, carrying in many bubbles of free air, the lesions on the fishes were more slowly produced, and the fatal result was postponed. The process of exposure deaerated the water, and had only to be made thorough enough to correct it completely by removing the excess. Thus, if the inflow was made to pass through a strainer elevated several feet above the aquaria, so that the water was divided into many very slender streams, which compelled intimate contact with the air during

the drop and in the splash at the surface, all mortality and symptoms of gas could be prevented. From water standing without flow in ordinary containers the excess of course finally disappeared, but in the large Woods Hole aquaria signs of excess were still evident after seven days. A cylindrical glass hatching jar of about 2½ gallons capacity, after filling with supersaturated water, required to stand two or three days before this water failed to produce an external precipitation on the body of a tomcod immersed in it as a test.

RÔLES OF NITROGEN AND OXYGEN IN CAUSATION OF THE DISEASE.

Some consideration may now be given to the separate rôles of the two gases nitrogen and oxygen in the disease. A reference to Table II, page 373, shows that the gas from the fixed gas lesions, that is, from the exophthalmia, from the fin blebs, and particularly from the chambers of the heart, is very high in nitrogen.

The sample from the sacs of rainbow-trout fry was taken from specimens preserved in formalin and some oxygen may have been lost on this account. All the others were from fresh material.

The samples upon which these figures are based were very small, and in obtaining them it was impossible to exclude with certainty all contamination from atmospheric sources. In each case a part of the small percentage of oxygen found certainly came directly from the air. The sample from the eyes of scup was most liable to this error. That from the hearts of various fishes indicates that the gas which causes the fatal embolism in the vessels is almost pure nitrogen, and samples from this source more accurately represent the gas as released from the blood than those from the external blebs or the tissues about the eyes. The one sample of the latter sort obtained was largely from scup in which gas had inflated the conjunctiva so that this gas was separated from the water only by a very thin transparent membrane, through which oxygen from the water may have diffused. Likewise all the fin blebs have but a similar osmotic membrane protecting the contained gas from changes in its original composition. The heart gas, however, doubtless represents solely a direct precipitation from the blood. It would appear, then, that it is the nitrogen gas chiefly, if not solely, which plays the essential part in the disease. The separation of gas from the supersaturated blood is certainly not in proportions analogous to that of the separation of nitrogen and oxygen from water supersaturated with air. In air-saturated water the oxygen is about 33 per cent of the total oxygen and nitrogen dissolved. In water air-supersaturated under the mechanical conditions here described the percentage of oxygen dissolved is slightly less, for the excess is not taken up in the same proportions that it is from the atmosphere. When unsaturated water is shaken with air at ordinary pressure, the residue of undissolved gas is richer in nitrogen than the

atmosphere. But in this mechanically induced supersaturation fragments of the atmosphere are forced bodily into solution in their entirety, and the dissolved content is increased by nitrogen and oxygen in atmospheric proportions, 79+21, instead of in dissolved proportions, 67+33. When the excess of these two gases escapes spontaneously from the water the oxygen has about the atmospheric relation to the nitrogen, i. e., about 21 per cent of the total, notwithstanding that while in solution the oxygen is more than 30 per cent of the total of these two. In other words the excess goes in as air and comes out as air. Thus the actual analyses already cited (p. 354) of precipitated gas from Woods Hole water, show the proportion of oxygen to be about as in air.

Since the blood does not release its supersaturation in this way, it is at once suggested that the hemoglobin capacity for oxygen modifies the effect of the water so far as the supersaturation with oxygen is concerned. It would appear that the corpuscles can take up more than the usual amount of oxygen and that the increment is not thrown out by the rise in temperature. It remains to study experimentally the effect upon fishes of water in which the supersaturation is with oxygen alone. Some evidence is afforded by an instance of such a supersaturation, naturally occurring, in a pond containing trout. At the Cold Spring Harbor Station of the New York Forest, Fish, and Game Commission, the springs which chiefly supply the station make immediately a shallow pond of considerable size. In the spring of 1904 the bottom of this pond became heavily overgrown with green algæ, chiefly with a species of *Spirogyra*. Presumably from these algæ, the water about the middle of the pond acquired an excess of oxygen of 3 c. c. per liter, while the nitrogen content remained normal, or but slightly in excess. Remote portions of the pond were normal in oxygen. Large trout lived in it in good condition and showed no gas symptoms, but the fact lacks conclusiveness since they had access to normal water, which they doubtless frequented. It is probable, however, that a large excess of oxygen is required to produce untoward results from this gas alone. In the conditions at Woods Hole, while the excess was of both oxygen and nitrogen, it is probable that the damage was done by the latter gas alone.

RELATION OF GAS DISEASE TO TEMPERATURE AND PRESSURE.

When water is here described as containing an excess of air, or an excess of oxygen or nitrogen, a definite relation of the quantity of gas to temperature and pressure is of course connoted. It is hardly necessary to insist that dissolved gas only is referred to, for loose bubbles present are not really in the water, though they may be beneath its surface or within its volume. The gas-disease process, then, bears an intimate relation to temperature and pressure. If a

given quantity of dissolved air per unit of water, at a given temperature and pressure, occasions a fatal process among fishes, a sufficient increase in the pressure or decrease in the temperature may render the water perfectly harmless to fishes; but it does so by abolishing the excess of air, though no change occurs in the absolute quantity of air concerned. The temperature factor alone is not so easily varied, and no direct experiments have been made involving it, but the statement above can hardly fail to be corroborated by such tests. For the pressure factor some interesting experimental facts have been obtained.

Scup placed in live boxes at or near the top of a reservoir storage tank of the Woods Hole water which was causing gas symptoms in aquaria were usually killed within twenty-four hours, the characteristic embolism and external symptoms always present. At the bottom of this tank, the depth of water being 8 or 9 feet, several days were required to produce the symptoms, and death occurred only after a still longer time. At half the depth the results were intermediate. There was a constant flow of water through the tank and it was evidently the hydrostatic pressure which inhibited the usual process. Carrying these observations further, a large glass jar was arranged to hold aquarium water with a constant flow and under a pressure varying between 6 and 7 pounds per square inch in addition to atmospheric pressure. Five adult scup were placed in this jar and remained alive under the pressure, without food, for twenty-nine days without developing any gas symptoms. The same water which flowed through the jar would at the beginning of the experiment at atmospheric pressure produce external lesions within twenty-four hours and was fatal within two or three days, the time varying considerably. After removal of pressure at the end of the experiment, all the five scup died within five days with free gas in the vessels of each. They were fed for the first time on the fourth day after the removal of pressure. During various experiments at Woods Hole some evidence was incidentally brought out indicating that starvation retarded the gas-disease process. This it may be conceived to do by a general lowering of metabolism.

Except under experimental conditions, no cases of gas disease caused by reduction of pressure alone have been observed by the writers, and it is doubtful whether any occur. In a former paper by one of us (Gorham, 1899) it was thought that the reduction of pressure was the only cause. The factor of the supersaturation of the water was not recognized at that time. From experiments performed in connection with that former work and new ones in connection with the present study we are sure that mere reduction of hydrostatic pressure—that is, the reduction incident on bringing fishes to the surface of the water—is not sufficient to produce the disease in those fishes which have been studied. A number of scup were kept in a live car at the surface of the

water outside the hatchery for twenty-four days and no symptoms of the disease appeared. At the end of this time, when placed in the supersaturated water of the aquaria, the same scup died quickly, with all the symptoms of gas disease. There is a considerable reduction of pressure brought about in bringing scup from their natural depths (2 to 20 fathoms) to the surface. The pressure at 5½ fathoms is twice that at the surface. But the fish can accommodate themselves to this reduction. The increased volume of gas in the air bladder is diminished through absorption by the blood, and the gills remove it by osmosis to the sea water.

Experimentally, however, reduction of pressure below that of the atmosphere is sufficient to produce the disease. The experiments reported in the previous paper (Gorham, 1899), which have been repeated and extended, demonstrate this. They were carried on by placing fishes in sea water in a large jar from which the air could be exhausted by a pump, and the vacuum secured measured by a gauge. Fishes could be killed very quickly (forty-four minutes) by a rapid reduction of the pressure to about 20 inches of vacuum, or about one-third of an atmosphere. These fishes gave the symptoms of gas disease such as the presence of a gas bubble in the heart and gas in the other vessels. By a less reduction, or by a series of reductions with periods of rest between, it was possible to bring about the formation of the external lesions of the disease, such as pop-eye, blebs in the fins, etc. Similarly an increase of pressure, brought about by forcing air into this same jar or by subjecting fishes to the pressure of a considerable depth of water, will cure or prevent the disease. Symptoms of the disease such as protruding eyes and blebs on the fins, which have been caused by placing fishes in supersaturated water, will disappear when the fishes are placed under these conditions of increased pressure. It should be said, however, that the presence or absence of an air bladder is probably important in determining the presence or absence of free gas within the blood vessels of fishes drawn from depths to the surface. There seems to be no reason why such fishes lacking an air bladder should show embolic gas or any free gas which was not free at the beginning of the change of depth. As far as the writers are aware, no observations have been made or are of record. While the saturation point of both water and blood at great depths is tremendously increased, deep waters do not have a greater air content than surface waters. They have, in fact, less of oxygen, and of nitrogen approximately the same as or less than surface waters, but never more. (Dittmar, 1884, p. 225.) This follows from the fact that the air in deep waters was taken up at the surface, and that the oxygen may be constantly diminished by oxidation processes while the nitrogen remains unchanged. The blood of deep-sea fishes without air bladders should never, therefore, contain more air than it can hold at the

coldest surface water. As for pressure conditions, then, no such deep-sea fish should liberate air from its blood when brought to the surface. Since, however, its habitat may be water whose nitrogen was dissolved at a low temperature, and it may be brought up into comparatively warm surface water, there exist theoretical conditions in which this result would be possible. That it actually occurs is unlikely, but is a matter for observation. The air-bladder factor has not been thoroughly worked out in the present study and is an interesting field for further experiment.

Although under these experimental conditions it is possible to produce the gas disease by reduction of pressure alone, yet the conditions are quite different from those which obtain when fishes are brought to the surface from depths. Fishes are in the habit of coming to the surface for short periods under natural conditions. They can accommodate themselves for short intervals, at least, to changes in pressure ranging from that at the surface to that of considerable depths, though the amount of gas to be eliminated when a fish with an air bladder comes to the surface is very large. When forcibly drawn up from considerable depths great changes take place, for the eyes bulge from the head and sometimes completely out of the sockets, the fish is often "poke-blown," the stomach and other viscera pushed into the cavity of the mouth, and the air bladder expanded or ruptured. The removal of pressure causes the free gas always present within the body to expand, and occasions displacement of tissues and organs. It is an interesting question whether such fishes have free gas within the blood vessels.

When the pressure is reduced below that of the surface, and quite rapidly, we would expect that the fish's powers of accommodation would be overstepped and they would not be able to take care of the surplus gas so quickly produced. No opportunity for adjustment is given. Still more when a fish is brought from a considerable depth and confined at the surface in water which is already supersaturated with gas, the gills would be unable to discharge the excess from the blood and the production of the gas disease would be hastened.

On the other hand, that the supersaturation of the water alone without the reduction of pressure is sufficient to produce the disease, we have abundant evidence. Surface fishes like *Fundulus*, usually quite hardy, succumb to the effects of the supersaturated water. Fresh-water fishes, like the trout, which have never been subjected to any decrease of pressure, quickly show the effects of supersaturation.

CONCLUSIONS.

In the light of these facts it seems to follow theoretically that no matter how great the quantity of air dissolved in water no gas disease can appear, provided the pressure is high enough; and conversely, no matter how high the pressure the gas disease will appear, provided

the quantity of air dissolved is great enough. Supposing the temperature constant, it is the interrelation of the dissolved air factor and the pressure factor which determines the fact of the excess, and since the condition of excess of air is to be defined only as a preponderance of the dissolved air factor over the pressure factor, the cause of the gas disease may be defined broadly as due to an excess of air; and more narrowly, since there is much evidence that nitrogen alone is essentially concerned, as due to an excess of nitrogen.

SUPERSATURATION OF NATURAL WATERS.

The symptoms and fatality at Woods Hole were the result of artificial conditions. A modification by the hand of man of the conditions under which air is usually taken up by the water resulted in an excess of the air so taken up. The pertinent question will immediately suggest itself whether natural waters ever acquire a similar excess, or any excess at all, of air or of the constituents of air. Such excesses are found to occur. Natural springs of water and flowing wells are known to emit a gas, sometimes in considerable quantities, which has approximately the composition of air. These are not very common.

Conditions at Erwin, Tenn.—Such a spring occurs on the reservation at the Fisheries Station at Erwin, Tenn., in a limestone region near the foot of a considerable mountain ridge. This spring has a superficial area of about 600 square feet and its maximum depth is about 4 feet. The bottom is partly of mud, partly of gravel and the outcropping of the limestone strata. The water wells up chiefly from the gravel, and from each wellspring a quantity of gas in large bubbles is evolved at intervals of a few moments. The gravelly bottom about the sources of water holds mechanically large amounts of gas, for, upon tapping it gently with a stick, an unusually large quantity is liberated and comes bubbling up through the water. The evolution of gas then ceases for a longer period than usual, but begins again spontaneously within a few minutes. This periodical delivery of gas continues day and night at all seasons. Evidently there is a constant flow of gas accompanying the flow of water and at all times in the earth or gravel beneath the spring and through which the water rises are entangled large quantities of gas, a small fraction of which is evolved every few minutes as the pressure beneath determines.

This gas is air with the nitrogen and carbon dioxid considerably increased. (Table I, p. 372, sample 1.) As springs do not usually discharge both water and free air, the original access of air is of more than passing interest. It is evident that it must be mainly derived from the atmosphere.

The region about this spring is mountainous and largely of a limestone formation, in which caverns have been formed by the usual process of solution of the limestone by water containing carbon dioxid.

The surface water percolates through cavernous limestone. An aspirating effect is probably produced by the flow through fissures and narrow channels which have access to air spaces, and the air is sucked in and mingled with the down-flowing water, which it accompanies to the mouth of the spring. During the journey a diminution of the oxygen may occur from oxidation, which may reasonably explain the modified proportions of these gases. Though the mountainous region referred to abounds in springs, only a single other bearing air was found, and this a small one by the roadside.

Air-bearing springs or wells of this character are to be distinguished from the "breathing" or "blowing" wells abundant in some sections, which alternately emit and suck in air from causes among which variations in the barometer are important. In Nebraska many wells having this remarkable peculiarity occur, and have been described by the United States Geological Survey (E. H. Barbour, 1899). The springs of supersaturation which deliver bubbles of air constantly are probably unrelated to breathing wells and, as far as known, pass the air in one direction only.

The water of this Tennessee spring was apparently of excellent sanitary quality—clear, cold (about 12° C.), slightly alkaline, and contained an excess of nitrogen, but not of oxygen. It was slowly fatal to fishes placed directly within the spring. Trout fry between 1 and 2 inches in length were killed by it sometimes within a day or two, although some individuals would survive in it for weeks. On fish of this small size no internal gas within the vessels was in any case demonstrated with certainty. Neither were external symptoms usually present, but in the hatchery troughs supplied by the spring they were more frequent and sometimes extremely conspicuous, consisting of emphysema of the skin, either single cysts of gas, sometimes of relatively great size, smaller multiple cysts, or small blisters of gas, which usually had their seat upon the head or mucous membrane of the mouth cavity. Apparently the only inconvenience the fry experienced from these was a mechanical one. The buoyancy of the gas was often great enough to keep them constantly at the surface, and its unequal lateral distribution gave them a list to one side or the other. They did not appear to be materially weakened.

When older trout, yearling rainbows 6 to 8 inches in length, were introduced into this spring, symptoms more closely resembling those at Woods Hole resulted. Death occurred with moderate symptoms of external gas, with gas free in the heart, though not abundant enough to cause distention, and with emboli of gas in the gill filaments. The susceptibility of species varied widely, and gold-fish were not affected during a trial of sixteen days, while other cyprinoids succumbed almost as readily as the trout. These experiments with fishes in the spring were made in live boxes and were controlled by the same or similar boxes in the spring water after it had passed from the spring and been

improved or corrected by exposure to the air, and these controls suffered no loss.

Determinations of the degree of excess of nitrogen in the Erwin water have not been made on freshly taken samples. The origin of the excess is to be looked for in the rising gas and the necessary pressure factor in the weight of the column of springing water. The air bubbles are presumably mingled with this water for a distance below the restricted areas of emergence in the spring in its subterranean course and even the whole distance back to its surface origin. The greatest depth reached by the water beneath the spring is unknown, but is estimated from the geology of the region to be at least 100 feet, and may be several hundred. This depth represents the height of the column of water, the pressure of which is operating constantly to force the air bubbles into solution. The supply of bubbles is abundant and never failing, and the water is bound to take up more air than it can hold when it reaches the surface and becomes exposed to the atmosphere at atmospheric pressure only. Here the excess begins to escape; and as the spring is shallow and well exposed, this process is rapid; yet the constant flow keeps the body of water constantly supersaturated. In flowing away from the spring in shallow exposed channels the water soon corrects itself, becoming normal and harmless to fishes. By applying devices in the hatchery, thoroughly exposing to the air the water supplying the troughs, the gas symptoms disappeared and the losses were reduced to the normal for all fish-cultural operations.

CONDITIONS AT NASHUA, N. H.

At the fisheries station at Nashua, N. H., occurred still another case of a water supply abnormal in its air content, and here an excess of nitrogen coexisted with various degrees of deficiency of oxygen. The station supply came largely from rather shallow artesian wells, some of which entered the hatchery directly, while others were driven in the bottom of the nursery and rearing ponds and on the edge of the larger brood ponds. Many field determinations of the dissolved oxygen and nitrogen in the water of the Nashua station were made and are shown in Table IV, page 374. There appears a deficiency of oxygen of greater or less degree and a moderate excess of nitrogen in the water of every source of supply save that from the taps of the Nashua city service. This latter water, however, at its source in artesian wells (Pennichuck wells) is even more abnormal as to dissolved air than is the station water, the oxygen being less, the nitrogen about the same. While not insanitary for city purposes, it would doubtless be fatal to fishes. The aeration and deaeration it receives in the open stream which takes it to the reservoir adjust these abnormalities, so that as delivered from the service pipes it has about a normal quantity of air. The same adjustment occurs with the station water after it has

flowed through the hatchery troughs, ponds, etc., and has gathered in a waste brook at some distance below the hatchery and pond system, save that the process has not been complete enough to remove all the excess of nitrogen ("creek water" sample, Table IV). In fact, the adjustment begins the instant the water emerges from the wells, and in most cases by the time it reaches the fishes it contains somewhat more oxygen and less nitrogen than at the well. The effect of the deaerating process on the loss of trout fry was shown by passing the "reservoir pond water" through a finely perforated metal plate with a fall of about 3 feet. During a trial of nine days a trough containing 6,000–7,000 fry lost 645, against a loss of 2,583 in a similar trough containing the same number, but supplied directly from the pond without deaeration. The process, which did not completely correct the water, reduced the loss 75 per cent. Complete correction would probably result from repeating the process or by sufficiently increasing the fall. The water of hatchery well No. 1 was completely relieved of its excess of nitrogen by allowing it to flow drop by drop down an inclined wooden plank 10 feet in length. (See Table IV, p. 374.)

Very few of the Nashua wells delivered free gas, and these only in small amounts. From one of these about 500 c. c. were delivered and collected during twenty days and constitute sample 2 of Table I. Only air gases were present. Part of the sample was tested for methane, unsaturated hydrocarbons, and carbon monoxide, without showing a trace of any of these. (Dr. D. A. Morton, Syracuse, N. Y.) The sample had no marked odor. The largest pond at the station, used chiefly as a reservoir supply and largely spring-fed, had a soft bottom from which occasional large bubbles rose. By ramming the mud with a stick, large quantities of a gas about 96 per cent nitrogen (Table I) could be released. Methane, which might have been expected, was absent. This gas seems to be of much the same origin as that from the air-bearing spring in Tennessee, though delivered in much smaller quantities, and may reasonably be supposed to come from a depth great enough to cause the supersaturation which existed in this pond, as in all the sources of water in the vicinity.

At the Nashua Station the gas symptoms were in evidence, but were less marked than in either of the other described cases of the results of supersaturated water. Exophthalmia with presence of gas appeared in adult trout in ponds, and the general condition of these trout was poor. This condition is believed to be secondary to the supersaturation, which, while not sufficient to kill the adults directly by embolism, causes the protrusion of the eye and consequent inflammation. The partial or total blindness resulting keeps them from feeding properly, and as they fall off in condition and become weaker they are attacked by the fungus *Saprolegnia*. Among the deaths which resulted no case of free gas within the vessels was discovered. The fry showed occasional gas blisters externally, and in very young fry gas was fre-

quently to be seen within the sac. Even in the Woods Hole water some few fishes, and many in the spring water of a lesser supersaturation, died without evidence of sufficient internal gas to produce an effectual embolism or enough apparent mechanical disturbance to account for death. Yet these fishes no doubt died of the excess of air. It is possible that in these cases there were internal lesions that escaped observation, minute emboli of gas, for instance, in the vessels of the brain, though in a number of brains examined no gas had reached their vessels. It seems probable that the metabolic functional disturbance due to the abnormal osmosis is itself sufficient to cause death without apparent gas symptoms.

EXOPHTHALMIA OR "POP-EYE."

Though not necessarily always occurring in all cases of supersaturated water, this affection is so prominent among symptoms of gas disease as to deserve special consideration. It is not an infallible sign of supersaturation. As "pop-eye" or "frog-eye" it has long been familiar to fish culturists, and these terms are vernacular for any protrusion of the eye from its orbit, whatever may be the essential cause. It is not a disease, but a symptom, the expression of any one of a variety of causes or underlying conditions. Inflammation, from a wound or other irritation within the orbital cavity, may cause a swelling of the tissues which pushes the eyeball outward from its position. Specimens of this sort are not very common in shallow natural waters. One specimen, a butter-fish (*Peprilus triacanthus*), which apparently falls in this class, was taken from the trap nets at Woods Hole August 3, 1903, and examined immediately by the writers. It showed a moderate exophthalmia on each side. The globus was still lenticular in shape, and on dissection under water no sign of gas was detected. The brain and optic nerves appeared normal. If there had been a traumatic injury evidence of it had disappeared. The inflammation was not pronounced, and while an exudate behind the eye was, in part at least, the immediate means of the displacement, the primary cause can not be given. Externally the condition simulated strongly that caused by supersaturation, to which in this case it could not possibly have been due.

Mechanical injuries alone, as a sudden blow upon the head, may produce an immediate protrusion of the eyeball (Hofer, 1904, p. 292).

Among the menhaden which died from the epidemic prevailing during the summer of 1904 in Narragansett Bay there were many cases of pop-eye, due, no doubt, to the injuries received during the peculiar death struggles characteristic of the disease. In some cases of pop-eye, where gas is plainly present and responsible for the displacement, it is possible that some other cause than supersaturation with air may be concerned, though none such is definitely known to the writers. In the great majority of cases where gas is present the cause will be

found to be an excess of air, with spring waters usually an excess of the nitrogen of the air alone, and the location of the gas will be behind the eyeball. Some species of fishes are not susceptible to this symptom from supersaturated water, or at least it has not been observed in them. The anatomical structure and the degree of the excess seem to be the factors which control. Among marine fishes, the dog-fish (*Mustelus canis*) and other sharks, eels, puffers, sea-robins, the flat-fishes, and others do not develop typical cases, if any, while the scup, the king-fish (*Menticirrhus*), the tautog, the cunner, the sea bass, and the butter-fish may exhibit it in various degrees. Of all these the scup (*Stenotomus chrysops*) shows it most readily and in extreme degree (Plate III). With a certain degree of excess not exactly known, but probably above 3 c. c. of nitrogen per liter, embolism becomes fatal before there is time for an accumulation of gas behind the eye. An excess of not over 2 or 3 c. c., and probably less, per liter is favorable to the development of the symptom, which may be taken to indicate a moderate excess of air. The eyeball is sometimes pushed almost completely out of the head (Gorham 1899, Plate 12). Without much displacement of the ball the conjunctiva may be raised and inflated into a balloon of gas projecting far out beyond the eyeball (Plates I and II of this paper).

Among fresh-water fishes salmonoids chiefly have been seen to be affected. The black sucker (*Catostomus nigricans*) showed a typical case at Erwin, while some cyprinoids (*Notropis galacturus* and a *Hybognathus*) under the same conditions died with the eyes normal. It is no doubt because not many fishes save the trout of artificial propagation have been observed in supersaturated fresh water that few fresh-water species are known to show the lesion. In brook and rainbow trout the pop-eye is seldom so extreme as that shown in the illustrations of the scup. The excess being slight, the symptom may grow very slowly and be present for months, or even years, impairing more or less the activities of the fish. Blindness frequently results, with accompanying increases of dark pigment in the skin. The exposure of the eyeball makes it subject to injury, and it is sometimes bitten off by other fishes, or drops or sloughs away, leaving the socket empty.

In trout fry past the sac stage a certain exophthalmia may develop after death if they remain in water, and the younger and smaller the fry the more quickly it appears. In general its development requires from twelve hours to three days. Evidently there is a physiological post-mortem accumulation of transudate behind the eye. There is a pathologic exudate which occurs in trout fry suffering from anemia and this exudate may localize, sometimes in the abdominal cavity, causing ascites, sometimes behind the eye, causing exophthalmia without gas. Fry having this form of anemia, though their eyes still be normal at death, more readily than healthy fry develop in water the post-mortem exophthalmia which in this case seems to be partly physio-

logic and partly pathologic. Likewise among a brood of fry suffering constant losses from supersaturated water many of the dead will be found with a greater or less, sometimes an extreme, exophthalmia without the presence of gas. It is a post-mortem occurrence, but the previous gas disease process seems to favor its development. All these cases, however, are to be carefully distinguished from the gaseous exophthalmia, directly a symptom of the gas disease.

The source of the gas behind the eye must be taken to be the blood. Its position appears to make it impossible that it be derived directly from the water. The blisters of gas which form upon the exterior of the body and fins seem explainable as derived from either source, and whether this gas has really passed through the blood of the fish or come through the permeable integument directly from the supersaturated water can not at present be stated, but the evidence is somewhat in favor of the latter view. It is probably chiefly in the large veins that the precipitation of the embolic gas from the blood occurs. The supersaturating gas is acquired at the gills, subsequent to which there is a fall of blood pressure. These facts make it probable that the peripheral circulation is supersaturated, and that an essential condition for the precipitation of gas at the periphery is supplied, though all the causes which combine to bring the dissolved gas in the blood of the capillaries free within the tissues are not clear. On the other hand, the presence of supersaturated water on one side of the very membranous covering of the fins, and on the other side tissues bathed in a lymph, which at the beginning is not supersaturated, suggests a more immediate reaction by the ordinary laws of osmosis.

THE CAISSON DISEASE ANALOGY.

The gas disease of fishes is paralleled in man by an affection in which, so far as it holds, the analogy is striking. The compressed-air disease—caisson illness, diver's palsy, etc.—is caused by an increase of air pressure; with divers, by the weight of the water above; in the caisson, by the compression necessary to keep the water out. In so far as the subject sustains an extraordinary pressure the analogy does not hold, for the gas disease involves no necessary increase of pressure upon the fishes themselves. But the osmotic process of gases passing into the blood through the lung membranes, under compression, must be intensified according to the height of the pressure, as it is through the gill membranes, in supersaturation, according to the degree of the excess. In this and in the results the two cases are much alike. The caisson disease has long been known and has a considerable medical literature, but some uncertainty seems to have existed as to the immediate cause of the symptoms and of death. The mechanical effect of the compression was supposed to be important, but recently the influence of this factor has been pronounced nil. Bubbles of gas in the blood vessels

are at the bottom of the trouble. Hill and MacLeod (1903) have the following to say:

> Paul Bert, by his remarkable experiments, published in 1878, proved that the true cause of caisson sickness is the effervescence of gas in the blood and tissue juices. * * * He found that this gas (nitrogen) was set free on rapid decompression and produced embolism in the lungs, the central nervous system, etc.; and that the gravity of the result depended on the height of the pressure, the length of exposure, and the rapidity of decompression. He also proved that the gas set free in the tissues might produce local swellings and emphysema.
>
> Bert also found that high oxygen tension acts as a general protoplasmic poison arresting metabolism, depressing the body temperature, and causing the discharge of convulsions in mammals and finally the death of all forms of life.

The following are a part of the summary by the same authors of experiments of their own:

> The cause of caisson sickness is the escape of gas bubbles in the blood vessels and tissue fluids on decompression. An animal exposed for four hours to 8 atm. air and quickly decompressed is like an opened bottle of soda water. The fluids of the body generally effervesce.
>
> The varying symptoms of caisson sickness are due to the varying seat of the air emboli.
>
> Young men escape caisson sickness owing to the elasticity of their tissues and greater facility for collateral pathways of circulation.

The effervescence of gas in the vessels of caisson workers is of course largely prevented by the precautions taken, but it is the logical result of compression followed by rapid decompression. With fishes there is, unless experimentally, no question of compression or decompression, but the gas symptoms occur under the conditions of supersaturation corresponding to compression, and no lowering or removal of supersaturation, corresponding to decompression, is necessary. The reason for this lies chiefly in the temperature factor already discussed. Theoretically the caisson worker should develop the effervescence while still under the compression, provided there is a difference of temperature between the systemic and pulmonary circulation and the exposure to compression is of long duration. This exposure is actually limited of course to a few hours at a time, and this may explain the absence of serious results during compression.

OTHER ANIMALS SUSCEPTIBLE TO GAS DISEASE.

Fishes are not the only aquatic animals susceptible to gas disease. The crustacea may survive a long time with the blood in a condition resembling foam, and in the lobster and king crab this has been readily observed through the abdominal shell. These latter usually live much longer than fishes under the same conditions of excess, but a lobster at Woods Hole was killed within thirty-six hours by an excess of about 6 c. c. of nitrogen per liter. Sea spiders (*Anoplodactylus*), as observed by Mr. L. J. Cole, are readily killed, the legs becoming filled with the gas and the color becoming much paler than in health. Mollusks, hydroids, and some green algæ also develop and emit bubbles which presumably originate in supersaturation.

EFFECT OF SUPERSATURATED WATER UPON EGGS AND FRY.

At Woods Hole sea water which was soon fatal to adults or fishes approaching maturity did not affect eggs and fry. Eggs of the cod were incubated for some two weeks in such water and the fry remained in it until planted—not more than a few days at most, it is true, but a longer period than would suffice to kill adults—yet neither were injured or showed any gas symptoms. It is probable, however, that very young fry are not necessarily immune under all conditions of supersaturation. Bubbles of gas have been noticed in the sacs of shad fry at fish cultural stations. Mr. J. N. Wisner (1900) reports such a case at Havre de Grace, Md., and the circumstances point to a leaky suction pipe, but nothing is known of the degree of supersaturation, if any existed. Theoretically it seems difficult to avoid the conclusion that oxidation must be attended by an elevation of temperature even in so minute a creature as a newly-hatched cod fry; but this elevation must be infinitesimal, for the consumption of energy necessary to maintain a temperature appreciably above the surrounding water is not supposable in the eggs or fry. As such an elevation of the blood temperature is the chief cause of gas precipitation in adults, its absence in the fry may be taken as strongly tending to explain their immunity. On the other hand, a sufficiently high degree of excess may be able to cause a separation of gas such as above noted among shad fry, either by direct osmosis or via the circulation.

METHODS OF PREVENTING THE GAS DISEASE.

The proper aeration of water, by artificial means if not already accomplished by nature, has from the beginning been recognized and insisted upon by fish culturists as of fundamental importance. By aeration was meant the process of putting the water thoroughly in contact with the atmosphere, so that the dissolved air would be increased were there any initial lack. In a proper fish-cultural sense, aeration more strictly meant oxygenation, for it was the oxygen alone, the prime necessity of fishes, which was apt to be lacking. No cases, perhaps, are known in which natural waters have less than their proper or normal amount of nitrogen. But of course the aeration process adds both the atmospheric gases should the water be lacking in both.

The readily observed distress and suffocation of fishes by the exhaustion of the dissolved oxygen in unrenewed water, the efficacy of even the simplest means of aeration in restoring the life-supporting quality to the water, as well as the generally understood necessity of oxygen to all animals, resulted naturally in an appreciation of the value and necessity of aeration. There were no observed facts from which one would infer the opposite condition in water, an excess of one or more of the air gases, nor were theoretical considerations likely to lead readily to its conjecture. It is improbable that any symptoms or mortality

from this cause occur in nature, for supersaturation does not arise suddenly and aquatic animals would avoid the regions of excess in the rare cases where access to them is possible. The possibility of injurious or fatal excesses of dissolved air, especially in natural waters, seems not to have occurred either to fish culturists or biologists.

The two faults, excess and deficiency of air, are so correlated that the same process of correction applies to each. The same exposure to the air which aerates water with a deficiency of air deaerates water with an excess of air. In superaerated water, such as that of the Woods Hole aquaria, there may be a deaeration in the more complete sense; both nitrogen and oxygen are to be removed. But in hardly any case does the term aeration apply in its complete signification. Oxygenation alone is usually the strict meaning. In natural waters the term deaeration likewise does not in most cases completely apply. Denitrogenation alone is the stricter meaning. Oxygenation, however, may accompany denitrogenation, and thus water is in the broad and looser sense aerated and deaerated at the same time and by the same process.

When an actual case of air-supersaturated water confronts the fish culturist or the management of aquaria, the practical measures to be taken will suggest themselves according to the source of the excess of air. If a gravity plant supplied by pumps is in operation the whole suction system is open to suspicion of leaks. Such leaks, of course, give out no water but suck air, and are therefore not always easily recognized. By stopping the pumps and removing the proper valve the hydrostatic pressure may be allowed to rest back on the suction pipe and will speedily develop the leaks if the pipe is exposed. If it is underground they may not show readily, or at all. Repair of all the leaks will completely remedy the difficulty. The suction pipes, especially if wooden, may be beyond repair, in which case nothing but a complete renewal will entirely prevent trouble. Pending this, local deaeration may be practiced at each aquarium, pond, or trough supplied with the water. For an aquarium a large pan with many perforations may be suspended above, the higher the better, and the water delivered into this. If the exposure of the slender streams and the splashing at the surface are not sufficient correction, the scale of the device has but to be increased, most conveniently by adding more perforated pans. The great desideratum is sufficient fall in which to expose the water.

When the supersaturated supply is from springs or wells the condition is more serious. A radical correction is impossible, for the air, or modified air, which causes the excess is deep in the earth and can not be controlled. If, as is usually the case, there is no great difference of level between the rising water and the ponds, troughs, or tanks in which it is used upon fishes, it is the more difficult or impossible to completely deaerate. The natural remedy is to use the water

only after it has flowed a considerable distance from its source in a shallow open stream. Failing this it may be carried through a circuit of a long and wide trough, to pass finally through perforated deaerating pans. In general a complete exposure to the atmosphere is necessary and the means for accomplishing this will vary with the conditions of each individual case. The deficit of oxygen is more readily supplied than the excess of nitrogen removed. The water eagerly takes up the oxygen it lacks, but the last traces of excess of nitrogen come away with difficulty.

When water rises as springs or wells in the bottom of the fish ponds themselves, it is still more difficult of correction, and quite impossible unless the head is strong enough to lift the water above the level of the surface of the pond, and so permit the adoption of the above measures.

It is a fact of significance and importance, to be considered from the standpoint of fish culture, that spring waters may vary considerably from time to time in the amount of dissolved air they contain. An instance of this, recently observed, concerned the oxygen alone, a marked deficiency being followed after several days and subsequent to a heavy rain, by a fairly abundant supply. It is inferred that nitrogen variations may likewise occur, and presumably changes in the solids in solution. Weather and seasonal conditions probably are contributing causes of this variability, but not many observations have been made and little is known beyond the fact, which makes it necessary not to place entire reliance on one examination of a given water.

In three instances of gas disease at government fish-cultural stations the excess of air has been actually determined by analysis. In others similar symptoms make a presumption of a similar cause. Meager information of other cases of disease or mortality among fishes with gas symptoms indicate with more or less probability the presence of supersaturation. A spring at an abandoned private trout cultural establishment in Vermont was found to be constantly giving up large bubbles of air (Table I, page 372, sample 5). Trout culture was not successful in this water, and the former superintendent gave a history of bulging eyes. Analyses were not made, but it seems extremely probable that this water was supersaturated.

In 1902, at the exhibit of the United States Fish Commission at the Charleston Exposition, a sudden and severe loss occurred among the marine fishes of the aquaria. The water precipitated quantities of gas, and the fishes were described as showing external bubbles and blisters of gas. The water supply was obtained by pumps with a long suction. The presumption is strong that the mortality was from excess of air, and that its sudden disappearance was caused by a change in the suction pipe, which, though unwittingly, corrected undetected leaks. The trouble was not explainable on other grounds than these.

The selection of water supplies for fish cultural or similar purposes should include a careful scrutiny of their quality with respect to dissolved air. There are the two opposite faults to be guarded against. When either is extreme in degree, its recognition will not be difficult. But it is probable that cases will occur, and have occurred, where either fault is but slight, and causes no heavy losses or marked symptoms on its own account, while it at the same time is responsible for a gradual and insidious lowering of condition among the fishes which makes them susceptible to the sudden and rapid epidemics of bacterial or protozoan infection, or to the less acute attacks of higher parasites. In such cases the certain recognition of a slight excess of nitrogen, with ordinary methods of gas analysis, may require the average of a number of determinations. The constant ebullition of gas in bubbles of moderate or large size from the water sources is sufficient to cause suspicion of a nitrogen excess, but the absence of such bubbles is by no means reassuring, for supersaturation may occur in the depths of the spring without any of the undissolved residual gas revealing itself at the surface. As for the oxygen, it is not known just what content short of saturation completely supplies all the needs of fishes, but since their natural abodes, and particularly trout streams, closely approach saturation (Hofer 1904, pp. 157 et seq.), it is well to lay stress upon the desirability of maintaining a high oxygenation in fish cultural waters. For trout, and particularly the brook trout, this is imperative. It is probable that most spring waters are not highly oxygenated. Usually they take up incidentally, in the conduits or at delivery pipes, more or less oxygen before they are actually used as a fish-cultural supply, and sometimes means of aeration are specifically provided. So important are these that it seems not too much to say that devices for this express purpose should be provided in all cases where spring or well waters are used for salmonoids, unless repeated quantitative determinations made at different seasons show that the water can not be improved.

TABLE I.—*Showing composition of gas delivered from the bottoms of ponds, springs, or wells.*

[All gas determinations by M. C. Marsh save where otherwise stated.]

Source of sample.	Date.	Percentage of—			Remarks.
		Carbon dioxid.	Nitrogen.	Oxygen.	
1. Spring at Fishery, Tenn.	May, 1903	0.8	82.5	16.7	Continual evolution of gas in large amount.
2. Artesian Well, Nashua, N. H.	Sept., 1903	.4	87.8	11.8	Discontinuous evolution of gas in small amount.
3. Fish cultural pond, Nashua, N. H.	Sept., 1903	.8	82.8	16.4	
4. Reservoir pond, Nashua, N. H.	Apr., 1904	1.4	96.3	2.3	
5. Spring in Vermont	Sept., 1903	Trace.	87.4	12.6	

Nos. 1, 2, and 5 were determined by the Bureau of Chemistry.

TABLE II.—*Showing composition of gas in lesions of the gas disease.*

Source of sample.	Percentage of—			Size of gas sample in c.c.	Remarks.
	Carbon dioxid.	Nitrogen.	Oxygen.		
Hearts of tomcod, sculpins, and hake at Woods Hole.	0	97.44	2.56	3.9	Possibly slight contamination with atmospheric ai in taking sample.
Body of lobster, Woods Hole...	0	94.2	5.8	3.4	Do.
Fin blebs of tomcod, flat-fish and hake.	0	92.1	7.9	7.6	
Eyes of exophthalmic scup, Woods Hole.[a]	0	80.4	19.0	[b]10	
Sacs of rainbow trout fry, White Sulphur Springs, W. Va.	0	92.3	7.7	2.6	Fry preserved in formalin.

[a] Analysis by Dr. M. X. Sullivan. [b] About.

NOTE.—None of the specimens from which gas samples were taken had been dead over thirty hours, and most of them a much shorter time. During this period they were in water at 10.5 ° C. There was no sign of putrefaction. The sample from the eyes of scup was taken immediately after the fish were killed.

TABLE III.—*Showing nitrogen and oxygen content (in cubic centimeters per liter, reduced to 0° C. and 760 mm., dry) of Woods Hole sea water under various conditions.*

Source.	Date.	Temperature of water, centigrade.	Actual content c.c. per liter.		Normal content of sea water when saturated with air at the given temperature and prevailing pressure, in c.c. per liter. Dittmar.		Excess + or deficit — c.c. per liter.		Remarks.
			Nitrogen.	Oxygen.	Nitrogen.	Oxygen.	Nitrogen.	Oxygen.	
Harbor under wharf.	1904. May 9	10.0	12.6	6.0	12.37	6.39	+0.23	—0.39	Harmless to fishes.
	No air entering the suction.								
Hatchery tap......	May 8	11.5	12.9	5.9	12.19	6.29	+0.71	—0.39	Harmless to fishes.
Aquarium tap.....	May 9	11.0	12.7	5.8	12.16	6.28	+0.54	—0.48	Harmless to fishes.
	With much air entering suction.								
Aquarium tap.....	May 10	9.75	17.73	8.16	12.54	6.49	+5.19	+1.67	Rapidly fatal to fishes.
Aquarium tap.....	May 10	9.75	18.23	8.34	12.55	6.49	+5.68	+1.85	Rapidly fatal to fishes.
Aquarium tap.....	May 10	10.0	18.79	8.54	12.48	6.45	+6.31	+2.09	Rapidly fatal to fishes.
Aquarium tap.....	May 11	10.5	18.01	8.06	12.37	6.38	+5.64	+1.68	Rapidly fatal to fishes.
Aquarium tap.....	May 11	10.5	18.79	8.41	12.37	6.38	+6.42	+2.03	Rapidly fatal to fishes.
	With a lesser amount of air entering suction.								
Aquarium tap.....	May 12	11.0	15.66	7.06	12.34	6.37	+3.32	+0.69	Less rapidly fatal.
Aquarium tap.....	1903. Sept. 18	20.8	12.5	4.9	10.28	5.24	+2.2	—0.34	Transported sample. U. S. Bureau of Chemistry.

TABLE IV.—*Showing nitrogen and oxygen content (in cubic centimeters per liter, reduced to 0° C. and 760 mm., dry) of various (fresh) waters at and near fisheries station, Nashua, N. H.*

Source of sample.	Date.	Temperature of water, centigrade.	Actual content c. c. per liter.		Normal content when saturated with air at given temperature, and prevailing pressure c. c. per liter.		Excess + or deficit − c. c. per liter.	
			Nitrogen.	Oxygen.	Pettersson and Sondén. N.	Winkler. O.	N.	O.
	1904.							
Hatchery well No. 1	Apr. 26	8.0	17.5	3.3	16.00	8.26	+1.5	−4.96
Same, second determination	Apr. 28	8.0	18.1	3.4	16.00	8.26	+2.2	−4.86
Same, deaerated drop by drop	Apr. 29	9.5	15.0	7.4	15.35	7.89	−0.35	−0.49
Hatchery well No. 5	May 3	8.0	17.8	2.9	16.14	8.33	+1.66	−5.43
Hatchery well No. 11	Apr. 30	8.0	18.6	1.6	15.72	8.11	+2.88	−6.51
Well in rearing pond No. 3	Apr. 27	8.0	17.5	3.1	16.00	8.26	+1.6	−5.16
Well in rearing pond No. 16	Apr. 28	8.0	17.9	3.8	16.00	8.26	+2.0	−4.46
Reservoir pond water	Apr. 27	8.75	17.2	5.0	15.77	8.13	+1.43	−3.13
Same, through deaerating box	...do...	8.75	16.4	6.7	15.73	8.11	+0.67	−1.41
Creek water, total station flow, aerated and deaerated by natural flow	Apr. 30	8.5	16.0	6.8	15.61	8.05	+0.39	−1.25
Largest Pennichuck well, source of Nashua city supply	May 2	11.5	17.6	2.1	14.94	7.65	+2.66	−5.55
Smaller Pennichuck well	...do...	11.5	18.3	2.2	14.91	7.65	+3.36	−5.45
Pennichuck water from service tap at hatchery	Apr. 29	7.0	15.4	6.6	16.24	8.40	−0.84	−1.80
Colerain Brook, a well-aerated natural stream	Apr. 30	12.0	14.5	7.0	14.45	7.39	−0.05	−0.39
Rain water freshly caught	Apr. 29	11.0	14.8	6.6	14.87	7.61	−0.07	−1.01

NOTES.—Presumably normal waters show, according to Tables III and IV, slight nominal excesses or deficiencies of nitrogen, and always a deficiency of oxygen. These discrepancies represent limits of accuracy of apparatus and methods as used in the field, and the personal equation. Moreover, saturation data vary within rather wide limits.

The figures for the dissolved CO_2 are not included in the tables, as having no particular relation to the present subject. They are considerably higher for fresh water containing a nitrogen excess than for normal water, the former averaging 5.3 c. c. per liter with extremes of 3.6 and 7.4, the latter 1.8 with extremes of 1.6 and 2.1. These figures include the semibound carbonate.

SUMMARY.

1. Fishes and some other organisms show gas symptoms of considerable variety and of a pathologic nature. Many of these are due to one cause and may be grouped together as a pathologic unity, the gas disease. An exophthalmia, or pop-eye, is one of the chief lesions.

2. Bacteria are not in any way concerned in the gas disease here considered, but may cause similar lesions.

3. The immediate cause of death in the gas disease is usually asphyxiation from gas embolism in the gill filaments, or heart, or both.

4. This embolic gas is due to an excess of dissolved air in the blood, which may be immediately caused by a rapid reduction of pressure, or by an excess of dissolved gas in the water, or by a combination of both.

5. The form of the disease caused by the reduction of pressure alone occurs only experimentally, or possibly in the case of some deep-sea fishes brought to the surface.

6. The form of the disease caused by an excess of dissolved air alone is the normal one. Nitrogen excess is more important than oxygen excess and can singly cause the disease process.

7. An excess of about 2 c. c. of nitrogen per liter of water is sufficient to cause symptoms. An excess of about 6 c. c. per liter, accompanied by an excess of about 2 c. c. of oxygen, experimentally produced, has been observed in sea water, and kills most adult fishes in a few hours.

8. A certain increase of pressure will prevent the gas disease where otherwise it would occur, and may cure affected fishes. It acts by changing the saturation point so that the excess of air no longer exists.

9. The supersaturated water may be corrected and become harmless by deaeration. This occurs spontaneously upon standing or may be more quickly accomplished by subdividing the water mechanically to offer a great area of exposure to the atmosphere. This process corrects either an excess or a deficiency of air. The water of shallow brooks arising in supersaturated springs or wells is soon corrected by the natural flow.

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A REVISION OF THE CAVE FISHES OF NORTH AMERICA

By ULYSSES O. COX
Professor of Biology, State Normal School, Mankato, Minn.

A REVISION OF THE CAVE FISHES OF NORTH AMERICA.

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This paper[a] deals with the taxonomic characters, the synonymy and distribution of the members of the Amblyopsidæ, a small group of fishes confined to the central and southeastern portions of the United States, apparently entering caves wherever caves exist within the limits of their distribution. They are the cave fishes par excellence of North America. Their relationships are with the Umbridæ or mud-minnows and the pikes and killi-fishes, and may be expressed by the following key to the families of the Haplomi, modified from Jordan and Evermann's Fishes of North and Middle America:

a. Lateral margin of the upper jaw formed by the maxillaries, premaxillaries not protractile; vent normal.
  b. Jaws depressed and produced, basis of cranium double .... *Esocidæ.*
  bb. Jaws not produced .... *Umbridæ.*
aa. Lateral margin of the upper jaw formed by the premaxillaries; basis of cranium simple.
  c. Vent close behind the isthmus; premaxillaries little protractile .. *Amblyopsidæ.*
  cc. Vent in normal position; premaxillaries extremely protractile ..... *Pœciliidæ.*

Several characters that have heretofore been used to distinguish the genera of the Amblyopsidæ have been examined in detail—namely, the character and distribution of the tactile ridges and the number of the pyloric cœca.

Tactile ridges.—While the tactile ridges peculiar to this family are undoubtedly better developed in the blind members of the family than in *Chologaster*, the difference is one of degree only. The same is true of the differences between the different species of *Chologaster*. In this genus they are best developed in *C. papilliferus*, and in this species they are better developed about the snout than elsewhere. A detailed comparison of the ridges of the head in the different species

[a] This paper has been prepared under the direction of Dr. Carl H. Eigenmann, who has furnished the material and literature for the work and given invaluable assistance. Cut 8 is by Mr. Thomas Large; pl. I and figs. 9 to 11, pl. II, are by Doctor Eigenmann and the author, figs. 4 to 6, pl. II; fig. 1, pl. IV; fig. 2, pl. V; and pl. VI by Doctor Eigenmann; pl. III from photographs made by Dr. D. W. Dennis; cut 22 is copied from the Proceedings of the U. S. National Museum for 1888, p. 168, and the remaining figures are by the author.

shows that while in some species 2 ridges may be coalesced into 1, or an additional ridge may be interpolated, barring such fluctuations, which are occasionally found even on opposite sides in the same species, the homologue of any ridge is present in all members of the family. The ridges are most conspicuous in the large *Amblyopsis*, though really more highly developed in the smaller *Troglichthys* and *Typhlichthys*. In the accompanying figures homologous ridges bear identical numbers. It will be seen from figures of *Amblyopsis* (1, 2, and 3, pl. I), which may be taken as the type, that the ridges form transverse (ridges 1, 2, 3, 4, 6, 7, 9, 10, 12, 13, and other series) or horizontal (ridges 5, 7, 11) series. Over the lateral line canals of the head the ridges are usually at right angles to the canals. On the sides of the head the vertical ridges form more (*Amblyopsis*, fig. 1, pl. I, and *Chologaster*, fig. 1, pl. II) or less (*Typhlichthys*, fig. 5, pl. I, and especially *Troglichthys*, fig. 4, pl. II) broken transverse lines.

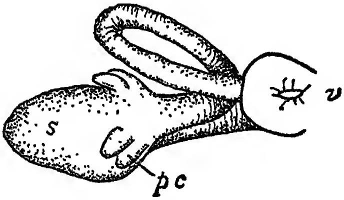
The papillæ in a number of the ridges were counted to ascertain whether or not the numbers were uniform in the same and in different species. The results of this count are given in the following table. The similarity is not marked, even in the two specimens of *Amblyopsis*. The numbers in the first column of the table correspond to the numbers of the ridges of the figures.

Number of papillæ in tactile ridges.

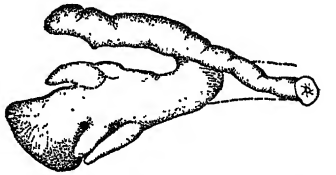
Numbers of ridges shown in cuts.	Amblyopsis spelæus.		Chologaster papilliferus.	Typhlichthys subterraneus.
	Specimen 86 mm. long.	Specimen 108 mm. long.	Specimen 51 mm. long.	Specimen 70 mm. long.
1	21	22	(?)	19
2	13	18	8	15
3	16	16	7	9
4	15	23	8	14
5	17	20	7	9
6	12	20	6	11
7	a 14 b 12	a 19 b 14	a 7 b 9	a 10 b 7
8	6	6	3	5
9	14	a 11 b 13	5	8
10	8	13	4	Out.
11	18	29	17	11
12	23	17	Out.	12
13	16	20	Out.	11
14	11	18	13	7
15	a 21 b 12 c 13 d 25	....	a 1.9 a 2.8 b 6 c 4	a 3 b 9 c 11 d 20
16	20	27	....	30
17	21	25	....	14
18	19	18	3	....
19	27	....	a 5 b 8	....
20	24	31	a 5 b 3	11
21	10	19	a 4 b 7	7
22	21	47	....	20
23	18	....	8	....

Numbers of ridges shown in cuts.	Amblyopsis spelæus.		Chologaster papilliferus.	Typhlichthys subterraneous.
	Specimen 86 mm. long.	Specimen 108 mm. long.	Specimen 51 mm. long.	Specimen 70 mm. long.
24	21	27	6	....
25	11	21	7	8
26	23	24	12	....
27	18	18	4	19
28	50	44	21	21
29	a 27 b 16	a 27 b 18	a 6 b 7	14
30	12	....	9	11
31	12	....	9	....
32	15	....	15	15
33	19	....	....	14
34	23	....	....	15
35	a 37 b 9 c 13 d 13	a 47 b 14 c 12 d 14	a 36 b 6	a 30 b 9 c 7 d 8
36	a 30 b 5 c 9 d 10	....	....	a 27 b 5 c 7 d 8
37	a 22 b 13 c 9	....	....	a 20 c 5 c 6 d 6
38	a 10 b 11	....	....	....
39	9	....	....	....
40	20	27	....	....
41	11	17	....	....
42	14	23	....	....
43	15	19	6	....

Pyloric cœca.—In the keys and descriptions in Jordan and Evermann's Fishes of North and Middle America, the number of pyloric cœca is taken as one of the characters on which is based the division of the *Amblyopsidæ* into genera. I have examined specimens of all of the North American species of this family and get results quite different from those recorded by the above authors and others who have written on the systematic characters of this group. The least number of pyloric cœca found in any specimen was 1 and the highest 4.

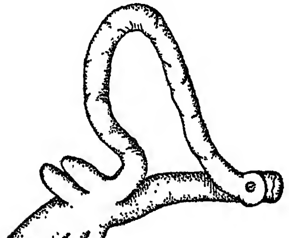


CUT 1.—Alimentary canal of *Chologaster cornutus*. *pc*, pyloric cœca; *s*, stomach; *v*, vent.

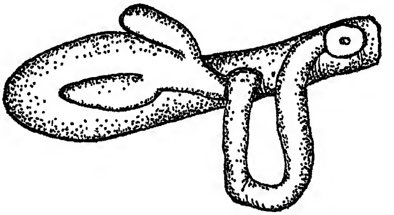


CUT 2.—Alimentary canal of *Chologaster papilliferus*.

Four specimens of *Chologaster cornutus* Agassiz were examined and in every case the number of pyloric cœca was 4. (Cut 1 shows the intestine and pyloric cœca of *C. cornutus: s*, the stomach; *pc*, the pyloric cœca; and *v*, the vent.) *Chologaster papilliferus* Forbes (cut 2), also has 4 cœcal appendages. In previous descriptions of this species but 2 cœca are noted. The four specimens of the rare *Chologaster agassizii* Putnam that were examined had 4 pyloric cœca each (cut 3). Nine specimens of *Typhlichthys subterraneus* Girard were examined, 5



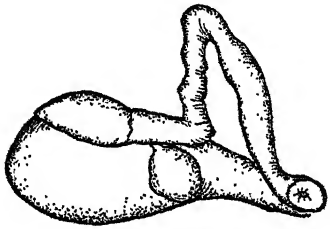
CUT 3.—Alimentary canal of *Chologaster agassizii.*



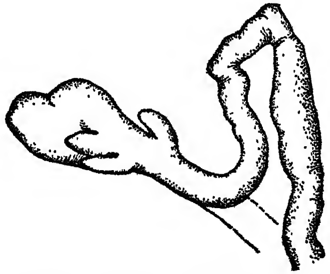
CUT 4.—Alimentary canal of *Typhlichthys subterraneus.*

from Mammoth Cave and 4 from Mitchells Cave, Kentucky. Seven of these had 2 distinct pyloric cœca each. Cut 4 shows a ventral view of the intestine of *T. subterraneus* and cut 5 a side view of another specimen of the same species with the gall-sac in position, the liver having been removed. In the other two specimens only 1 pyloric cœcum could be found in each, but the specimens were poorly preserved and possibly the second appendage had disintegrated. The cœcal appendages in *Amblyopsis spelæus* De Kay were found to vary

slightly. Of 22 females examined, 3 had 3 pyloric cœca each and the remainder but 2. Of 22 males 4 had 3 cœca and the remainder 2. In all the specimens of each species when but 2 pyloric cœca occur they are located 1 on either side of the cœcum. The 2 appendages are never opposite. In all cases the right cœcum is located about its width in front of the left. When 3 appendages are present the third is



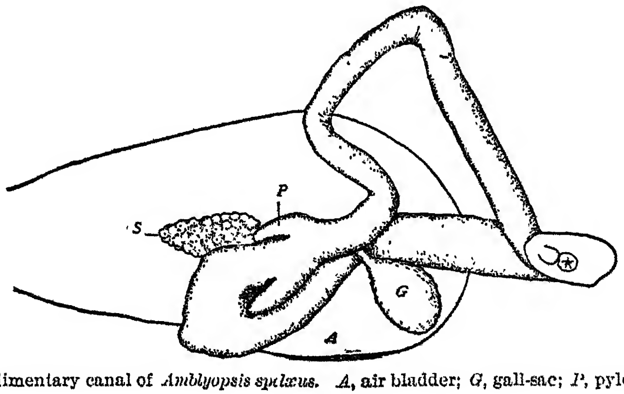
CUT 5.—Alimentary canal of *Typhlichthys subterraneus*, side view, showing gall-sac.



CUT 6.—*Amblyopsis spelæus*, showing three pyloric cœca.

always just back of the normal one, the 2 normal appendages retaining their usual positions. Cut 7 shows the normal position of the pyloric cœca (P) in *Amblyopsis*. Cut 6 shows the 3 cœca in another specimen. But 1 specimen of *Troglichthys rosæ* Eigenmann was examined and this had 2 pyloric cœca (cut 9).

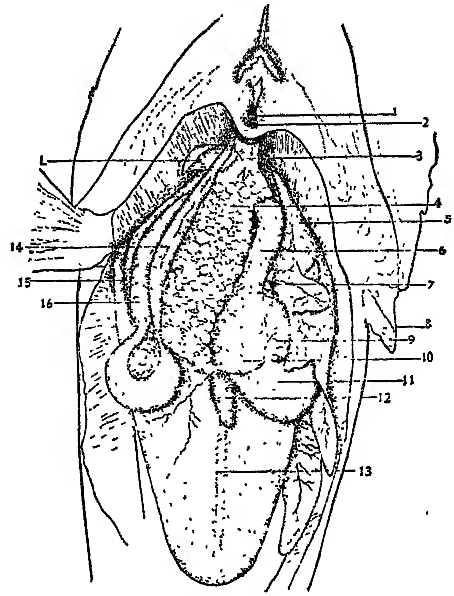
The general characters of the *Amblyopsidæ* may be summed up as follows: Body varying considerably in shape in the different genera,



CUT 7.—Alimentary canal of *Amblyopsis spelæus*. *A*, air bladder; *G*, gall-sac; *P*, pyloric cœca; *S*, spleen.

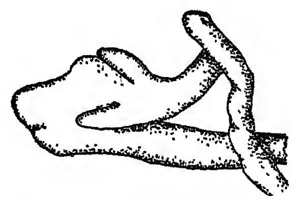
but in all rather heavy anteriorly and the posterior portion compressed; head more or less depressed, its upper surface quite flat in *Amblyopsis;* mouth large, the lower jaw generally projecting beyond the upper; premaxillary not strictly protractile, although not firmly joined to the ethmoid, and forming the entire margin of the upper jaw; bands of villiform teeth on the dentary, premaxillary, and palatine bones; branchiostegal rays 6; gillrakers very short; gill mem-

branes joined to the isthmus, sometimes loosely; body covered with very small, irregularly arranged cycloid scales; no lateral line; vent in the young located in the normal position, but in the adult far for-



CUT 8.—Internal anatomy of *Amblyopsis spelæus*. 1, anus; 2, opening of the oviduct; 3, oviduct; 4, ovary, which is single; 5, liver; 6, duodenum; 7, gall-sac; 8, pectoral fin; 9, one of the pyloric cœca; 10, cœcum; 11, stomach; 12, spleen; 13, air-bladder; 14 and 16, intestine; 15, pancreas; L, liver.

ward, just behind the angle of the union of the gill membranes. The transition of the vent from what is its usual position in most fishes to this unusual one just back of the gill openings takes place gradually as the fish matures[a]; ventral fins wanting except in *Amblyopsis*, very small in this species; pectorals inserted rather high, moderate in size; no spines in any of the fins; dorsal and anal fins nearly opposite; caudal rounded or even pointed at the tip; no median crest on the cranium; stomach cœcal, with 2 to 4 pyloric cœca; air-bladder well developed; ovary always single. Eggs caught by the gills when spawned, at least in *Amblyopsis*, and held there until hatched; young remain in the gills in *Amblyopsis* until about four-tenths of an inch long.[b]



CUT 9.—Alimentary canal of *Troglichthys rosæ*.

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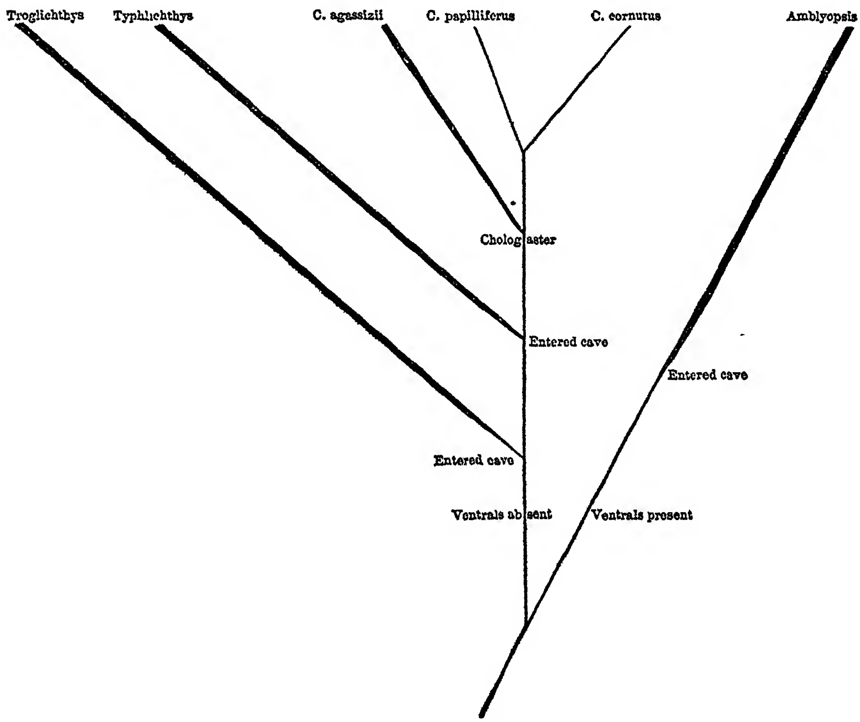
[a] In a specimen of *Amblyopsis* 1.26 inches long the anus is just below the insertion of the pectorals. In a specimen 1 inch long it is nearer the ventrals than the pectorals. In a specimen of *Typhlichthys* 1.1 inch long the anus is well in front of the pectorals, but a short distance behind the gill.—Eigenmann, Pop. Sci. Mo., LVI, 1900, 485.

[b] Eigenmann, Marine Biological Lectures, 1899, 313.

Cut 10 indicates the probable relationship of the species. The ancestry of the blind fishes is unknown.[a] At first the group divided into 2, those with and those without ventral fins. *Troglichthys* probably entered the caves first, for its eyes have degenerated farther than any of the species. *Amblyopsis* and *Typhlichthys* probably entered about the same time. *Chologaster agassizii* has only recently entered caves, *C. papilliferus* is found only in cave springs in southern Illinois, and *C. cornutus* occurs in the southeastern United States in open waters.



CUT 10.—Diagram indicating probable phylogeny of the Amblyopsidæ.

KEY TO THE GENERA OF AMBLYOPSIDÆ.

a. Eyes quite well developed; body more or less colored; ventral fins obsolete; pyloric cœca 4 .... *Chologaster*.

aa. Eyes rudimentary and concealed beneath the skin; body colorless; pyloric cœca 2 (occasionally 3 in *Amblyopsis*).

b. Ventral fins absent.

c. No scleral cartilages present .... *Typhlichthys*.

cc. Large scleral cartilages present .... *Troglichthys*.

bb. Ventral fins present .... *Amblyopsis*.

[a] Eigenmann, Science, N. S., 1899, IX, 282.

Doctor Eigenmann has worked out the following key to the Amblyopsidæ, based on the structure of the eye:[a]

a. Vitreous body and lens normal, the eye functional; no scleral cartilages; eye permanently connected with the brain by the optic nerve; eye muscles normal; no optic fiber layer; minimum diameter of the eye 700 μ .... *Chologaster.*

b. Eye in adult more than 1 mm. in longitudinal diameter; lens over 0.5 mm. in diameter; retina very simple, its maximum thickness 83.5 μ in the old; the outer and inner nuclear layers consisting of a single series of cells each; the ganglion layer of isolated cells; maximum thickness of the outer nuclear layer 5 μ, the inner layer 8 μ .... *cornutus.*

bb. Eye in adult less than 1 mm. in longitudinal diameter; lens less than 0.4 mm.; outer nuclear layer composed of at least two layers of cells; the inner nuclear layer of at least three layers of cells, the former at least 10 μ thick, the latter at least 18 μ.

c. Pigment epithelium 65 mm. thick in the middle aged, 102 in the old........ *papilliferus.*

cc. Pigment 49 μ thick in the middle aged, 74 in the old; 24 to 30 per cent thinner than in *papilliferus;* eye smaller........ *agassizii.*

aa. The eye a vestige, not functional; vitreous body and lens mere vestiges; the eye collapsed, the inner faces of the retina in contact; maximum diameter of the eye about 200 μ.

d. No scleral cartilages; no pigment in the pigment epithelium; a minute vitreal cavity; hyaloid membrane with blood vessels; pupil not closed; outer nuclear, outer reticular, inner nuclear, inner reticular, ganglionic, and pigment epithelium layers differentiated; cones probably none; no eye muscles; maximum diameter of the eye 180 μ; eye probably connected with the brain throughout life........ *Typhlichthys.*

dd. Scleral cartilages present; pigment in the pigment epithelium; vitreal cavity obliterated; no hyaloid membrane; pupil closed; some of the eye muscles developed; no outer reticular layer; inner and outer nuclear layers merged into one; eye in the adult not connected with the brain.

e. Pigment epithelium well developed; cones well developed; ganglionic cells forming a funnel-shaped mass through the center of the eye; pigment epithelium over the front of the eye without pigment; maximum diameter of the eye about 200 μ........ *Amblyopsis.*

ee. Pigment epithelium developed on the distal face of the eye, rarely over the sides and back; no cones; nuclear layer mere vestiges; the ganglionic layers restricted to the anterior face of the eye just within the pigment epithelium; maximum diameter of the eye about 85 μ........ *Troglichthys.*

CHOLOGASTER Agassiz.

Chologaster Agassiz, Amer. Jour. Sci. and Arts, XVI, 1853, 135 (*cornutus*).

The genus *Chologaster* is distinguished from the other genera of the *Amblyopsidæ* by the presence of well-developed eyes, which vary greatly in the different species of the genus. All of the species pos-

[a] Eigenmann, Eyes of the Blind Vertebrates of North America, Archiv für Entwickelungsmechanik der Organismen, VIII, 1899, 607.

sess more or less dermal pigment and thus are colored much like ordinary fishes. There are four pyloric cœca, and each species possesses tactile ridges.

KEY TO THE SPECIES OF CHOLOGASTER.

a. Eye large, contained 5.5 times in the head; species of dark coloration.
 b. Sides with 3 well-defined longitudinal lines, the middle one broadest; tactile papillæ very small .... *cornutus.*
 bb. Dark lines present on the sides of the body but much fainter than in *cornutus;* tactile papillæ large .... *papilliferus.*
aa. Eye very small, contained 10 times in the head; coloration faint .... *agassizii.*

Chologaster cornutus Agassiz.

The body of this species is rather slender, its length being contained from 5.25 to 6.5 times in its length; head considerably depressed, 3 to 3.5 in body; mouth large, terminal, oblique, the lower jaw projecting; maxillary extending to near front of eye; eye small, about half length of snout and so located as to be able to see upward as well as sidewise; gill-membranes united and loosely joined to the isthmus, reaching back to or covering the vent; pectoral 1.5 in head and 1.4 in distance from snout to front of dorsal fin; caudal fin considerably pointed, about equal to head; dorsal with 8 to 9 rays, its front nearer base of caudal than tip of snout; anal with 8 to 9 rays, inserted almost directly under dorsal; scales very small, cycloid and not arranged in regular rows; no lateral line; tactile ridges present but very small; about 70 scales in a straight line along side from head to caudal fin; head naked. Color dark brown above, lighter on sides and white on belly; side with 3 narrow, well-defined longitudinal dark lines, the middle one, which is deepest and widest, extending across head and eye to tip of snout, upper line nearer to back than to middle line; a dark black blotch on base of caudal; remainder of caudal variously mottled with black. There is sometimes a white crossbar about the middle of the caudal, but this may be reduced to 2 small white spots; tip of fin frequently white. In some specimens the back is entirely black and the dorsal fin white, spotted with black. The color, no doubt, varies much with the conditions. Length of the largest specimen known, 1.8 inches.

CUT 11.—*Chologaster cornutus.*

This little fish inhabits the swamps of the southern United States from the Dismal to the Okefinokee. It is said to be abundant locally, but at present there are very few specimens in the museums, so far as I am able to learn. Those examined were from the Dismal Swamp, Virginia, and were kindly loaned by the United States National Museum.

The specimens described as *C. avitus* prove to be a variation of *C. cornutus*, the difference being chiefly one of color.[a]

[a] Jordan and Evermann, Fishes of North and Middle America, I, 703, 1896.

Measurements.

No.	Head.	Depth.	Dorsal.	Anal.	Scales.	Length.	Notes.
1	3.5	6	8	8	66	33	Dismal Swamp.
2	3.33	5.25	(?)	9	63	25	Do.
3	....	....	9	9	....	....	Dismal Swamp (mutilated).
4	3	5.5	9	8	....	30	Cotype of *C. avitus*.
5	3	5.5	9	9	....	19	

Chologaster cornutus Agassiz, Amer. Jour. Sci. and Arts, XVI, 1853, 135, **Ditches of rice fields in South Carolina.** Günther, Cat. Fishes Brit. Mus., VII, 2, 1868. Putnam, Amer. Nat., VI, 1872, 30. Jordan & Gilbert, Synopsis Fishes of N. A., 325, 1883. Gilbert, Bull. U. S. Fish Comm., VIII, 1888, 22 (Okefinokee Swamp, Millen, Georgia). Jordan & Evermann, Fishes North and Mid. Amer., I, 703, 1896. Eigenmann, Degeneration of the Eyes of the Amblyopsidæ, its Plans, Processes, and Causes, Proc. Ind. Ac. Sci. 1898, 239 (summary); Eyes of the Blind Vertebrates of N. Amer., Arch. f. Entwickelungsmech., VIII, 1899, 543; Marine Biological Lectures, 1899 (1900), 113.

Chologaster avitus Jordan & Jenkins, in Jordan Proc. U. S. Nat. Mus., VIII, 1888, 356, pl. 44, fig. 8, **Outlet of Lake Drummond, Dismal Swamp, near Suffolk, Va.**

Chologaster papilliferus Forbes. Pl. IV, fig. 2.

The body is similar in shape to that of *C. cornutus.* Depth about 6 in length; head 3.5 to 3.75, not quite so depressed as *C. cornutus;* mouth very oblique, lower jaw projecting as much or more than width of eye; maxillary scarcely reaching eye; eye 2 in snout, located rather on upper side of head; head and body with papillary ridges which serve as tactile organs, these highly developed in some specimens and almost entirely absent in others; gill-membranes more or less united, loosely joined to the isthmus, reaching back to the vent; pectoral reaching half way to dorsal; caudal pointed; dorsal inserted well back, its first ray a little in front of first ray of anal, rays 8 to 9; anal with 8 rays; scales very small, and arranged as in *C. cornutus* but somewhat more numerous. Color similar to that of *C. cornutus*, but the dark longitudinal lines not so well defined; a light lateral line just below the median dark line; no well-defined black blotches on base of caudal; belly white; dorsal fin dark, similar to caudal; anal light; upper part of head dark. Length 2 in.

This species differs from the others of the genus in the strong development of papillary ridges and in color. It is generally lighter than *C. cornutus* and darker than *C. agassizii.* Known only from Clinton County, Illinois, in cave springs.

Measurements.

No.	Head.	Depth.	Dorsal.	Anal.	Scales.	Length.	Notes.
1	$3\frac{1}{2}$	6	8	8	97	35	Papillæ distinct.
2	$3\frac{3}{4}$	....	9	8	....	43	Papillæ indistinct.
3	3	....	....	....	....	25	Do.
4	....	....	8	....	....	25	Do.
5	$3\frac{7}{8}$	$5\frac{1}{2}$	8	9	....	49	Papillæ distinct.
6	4	$5\frac{3}{4}$	8	9	....	51	Do.
7	4	$5\frac{1}{4}$	8	9	....	40	Do.

Some of the specimens were more or less imperfect, and Nos. 3 and 4 were so small that accurate measurements could not be taken. The scales were not counted, except on the first specimen. The specimens examined were taken by Mr. E. B. Forbes from a cave spring in southern Illinois.

Chologaster papilliferus Forbes, American Nat., Jan., 1882, **Cave spring in southern Illinois.** Jordan & Gilbert, Synopsis Fishes N. A., 325, 890, 1883. Jordan & Evermann, Fishes North and Mid. Amer., I, 704, 1896. Eigenmann, Proc. Ind. Ac. Sci., 1897 (1898) 231; Degeneration in the Eyes of the Amblyopsidæ, its Plans, Processes, and Causes, Proc. Ind. Acad. Sci., 1898, 239 (summary); Eyes of the Blind Vertebrates of N. A., Archiv. f. Entwickelungsmech., 1899, 545; Marine Biological Lectures, 1899 (1900), 113.

Chologaster agassizii Putnam. Pl. V, fig. 2.

Body rather heavy but elongated, its depth 6 to 6.5 in length; head 3.50 to 4.33; mouth very oblique, lower jaw projecting, maxillary reaching to the eye; eye very small and covered with skin, probably only partially functional, located more on upper side of head than the eyes of *C. cornutus* and *C. papilliferus;* gill-membranes joined to isthmus, not covering vent; pectoral fin 1.40 in head; caudal rounded, its length from base to tip less than head; dorsal with 8 or 9 rays, somewhat rounded, inserted nearer base of caudal than tip of snout, its front farther forward than front of anal; anal 8, smaller than dorsal; scales similar to those of *C. papilliferus;* no tactile papillæ present.

Since this species lives entirely in caves, it is much lighter in color than either of the other 2 species of the genus. The myotomes are very distinct, and form the 3 usual angles along the sides of the body. The aponurotic septa, or lines between the myotomes, are dark, and merge together to form a distinct dark line at the apex of the upper angle. The apex of the middle angle is also visible for the same reason, although this line is not so dark. The line along the apex of the lower angle is much darker than that of the middle, but not so dark as the upper. By the merging of these lines 3 dark longitudinal lines along the side of the body are formed, the upper darkest, the middle one faintest but widest, and the lower one intermediate. Along the back, beginning at the base of the caudal and coming to the point just back of the head, is a yellowish line. The edges of the scales are

darkest, consequently the sides and upper part of the body appear gray. There is an ill-defined dark spot at the base of the caudal and there are dark lines on the body at the base of the dorsal and anal fins. The fins vary in color from light gray to white, belly white. Length 2 in.

This rare fish was first described by Putnam in 1872 from a well near Lebanon, Tenn., and it has very rarely, if ever, been taken since, so far as I am able to determine, until November, 1898, when Dr. C. H. Eigenmann secured 4 specimens from Mammoth Cave and Cedar Sinks, Kentucky. The chief points which distinguish this from the other species of the genus are the smaller eye and the lighter color. Tactile ridges are present, but they are not so prominent as in *C. papilliferus*. The fish is not found outside of caves or underground streams. The specimens examined were those from Mammoth Cave and Cedar Sinks, Kentucky.

Measurements.

No.	Head.	Depth.	Dorsal.	Anal.	Scales.	Length.	Notes.
1	$4\frac{1}{3}$	$6\frac{1}{2}$	9	8	(?)	52	
2	$3\frac{2}{3}$	6	8	8	(?)	30	
3	$3\frac{1}{2}$	6	9	8	(?)	34	
4	....	....	8	8	....	....	Mutilated specimen.

Chologaster agassizii Putnam, Amer. Nat., VI, 1872, 22, well at Lebanon, Tenn., Mammoth Cave, Ky. Jordan, Rept. Geol. Nat. Res. of Indiana 1874 (1875), VI, 218 (reference to Putnam's specimens). Hay, Geol. and Nat. Res. of Ind., XIX, 1894, 234. Jordan & Evermann, Fishes North and Mid. Amer., I, 704, 1896. Eigenmann, Proc. Ind. Ac. Sci. 1897 (1898), 230; Eyes of the Blind Vertebrates of N. A., Archiv. f. Entwickelungsmech., VIII, 1899, 546; Proc. Ind. Ac. Sci., 1898 (1899), 239, 251; Marine Biological Lectures, 1899 (1900), 113.

TYPHLICHTHYS Girard.

Typhlichthys Girard, Proc. Ac. Nat. Sci., Phila., 1859, 62 (*subterraneus*).

No ventral fins present. Otherwise similar to *Amblyopsis*, except that it does not grow to be so large. The genus includes probably three species.

Typhlichthys subterraneus Girard. Pl. V, fig. 1.

Body a little heavier than in *Chologaster*, its depth 6 to 6.5 in the length; head much depressed, 3 to 3.5 in the length; mouth large, oblique, lower jaw a little projecting, snout broad and rounded; eye entirely covered; gill cavities somewhat enlarged; gill membranes united to the isthmus; branchiostegals 6, fitting closely to the body, reaching back to the vent; pectoral fins 1.5 in head; front of anal a little back of front of dorsal; anal with 8 rays; dorsal 8; caudal rounded in perfect specimens; scales similar to those of *Chologaster;* pyloric cœca 2.

General color in life, yellowish pink, alcoholic specimens yellowish; fins slightly mottled with black. Length of the largest specimen about 2 in.

This species is rather abundant in the streams south of the Ohio and east of the Mississippi. The specimens examined are from Cave City, Ky., Roaring River in Mammoth Cave, and Mitchells Cave at Glasgow, Ky.

Measurements.

No.	Head.	Depth.	Dorsal.	Anal.	Scales.	Length.	Notes.
1	3	6	8	8	....	43	From Mammoth Cave, Ky.
2	3	6	8	8	....	42	From Mitchells Cave, Ky.
3	3½	6½	8	8	....	39	Do.
4	3¼	6¼	8	8	....	35	Do.
5	3	6½	8	8	....	40	From Mammoth Cave, Ky.
6	3	6	8	8	....	45	Do.
7	3½	6	8	8	....	22	Do.
8	3⅓	6	8	8	....	33	Do.

Typhlichthys subterraneus Girard, Proc. Ac. Nat. Sci., Phila. 1859, 62, well near Bowling Green, Ky. Putnam, Amer. Nat., VI, 1872, 17 (Mammoth Cave, Kentucky). Jordan, Rept. Geol. and Nat. Res. of Ind. 1874 (1875), VI, 218 (Mammoth Cave, Kentucky). Jordan & Gilbert, Synopsis Fishes of N. A., 325, 1883. Hay, Geol. and Nat. Res. of Indiana, XIX, 1894, 234. Jordan & Evermann, Fishes North and Mid. Amer., I, 704, 1896. Eigenmann, Eyes of the Blind Vertebrates of N. A., Archiv. f. Entwickelungsmech., 1899, 545; Proc. Ind. Ac. Sci. 1898, (1899), 239 (summary).

Typhlichthys wyandotte Eigenmann.[a]

A single specimen taken from north of the Ohio River from a well near Corydon, Ind., is probably a distinct species. It differs slightly from those south of the Ohio, being somewhat more slender. The Corydon specimen is 1.65 inches in length from tip of the snout to base of caudal; other measurements are as follows: Head 3.66 in length; width of head in length of body 6.50, 1.66 in its own length; distance from posterior margin of skull to front of first dorsal ray, 16 mm.; front of dorsal to middle of caudal, 17 mm.; first anal ray nearer base of middle caudal ray than anus. Specimens from south of the Ohio River, 42 mm. long, measure as follows: Head 3 to 3.25 in length of body; width of head in length of body 5, 1.50 to 1.60 in its own length; distance from base of skull to first dorsal, 15 mm.; front of dorsal to middle ray of caudal, 17.5 mm. First anal ray about equidistant from base of middle caudal ray and anus.

Typhlichthys subterraneus Eigenmann, Proc. Ind. Ac. Sci. 1897 (1898), 230 (Corydon, Ind.); not of Girard.

Typhlicthys wyandotte Eigenmann, Biol. Bull., VIII, Jan., 1905, 63.

[a] In the Biological Bulletin, VIII, 65, Dr. C. H. Eigenmann described another new species, *Typhlicthys osborni*, from Horse Cave, Ky., with narrower and shorter head, smaller eye, which is surrounded by prominent fatty masses, and swollen cheeks.

TROGLICHTHYS Eigenmann.

Troglichthys Eigenmann, Science, N. S., IX, 1899, 280 (*rosæ*).

This genus is very much like *Typhlichthys*, from which it differs in the structure of the eyes, especially by the presence of large scleral cartilages.

Troglichthys rosæ (Eigenmann). Pl. IV, fig. 1.

Body similar to that of *Typhlichthys*, but slightly heavier. Depth 4.5 in head; head 3, depressed; mouth oblique, lower jaw slightly projecting; snout rounded; eye not visible, considerably smaller than that of *Typhlichthys;* gill membranes joined to isthmus; head and body well supplied with tactile ridges; fins similar to those of *Typhlichthys*; dorsal with 8 rays; anal 8; pyloric cœca 2. Color in life, yellowish pink, no dark spots anywhere. Length 1.167 in.

T. rosæ inhabits subterranean waters in southern Missouri, northern Arkansas, and probably eastern Kansas. The type specimens are from the caves at Sarcoxie, Mo. It is this species whose habits Doctor Garman and Miss Hoppin have studied.

The following is quoted from Doctor Eigenmann in Science, N. S., IX, 1889, 280. "On the surface the specimens very closely resemble *Typhlichthys subterraneus* from the Mammoth Cave. * * * It is, however, quite evident from a study of their eyes that we have to deal here with a case of convergence of two distinct forms. They have converged because of the similarity of their environment, and especially owing to the absence of those elements in their environment that lead to internal protective adaptation. * * * The eye of *Typhlichthys* is surrounded by a very thin layer of tissue representing the sclera and choroid. The two layers are not separable. In this respect it approaches the condition in the epigæan-eyed member of the family, *Chologaster*. The eye of *Troglichthys rosæ* is but about one-third the diameter of that of *Typhlichthys subterraneus*, measuring 0.06 mm. or thereabouts. It is the most degenerate, as distinguished from the undeveloped vertebrate eye. The point of importance * * * is the presence of comparatively enormous scleral cartilages. * * * This species is unquestionably descended from a species with well-developed scleral cartilages, for it is not conceivable that the sclera as found in *Chologaster* could, by any freak or chance, give rise during degeneration to scleral cartilages, and if they did they would not have developed several sizes too large for the eye. At present no known epigæan species of the *Amblyopsidæ* possesses scleral cartilages and the eye of *rosæ* passes through a condition similar to that possessed by *Amblyopsis*, but the latter species has ventral fins, and is hence ruled out as a possible ancestor of *rosæ*. * * * Judging from the degree of degeneration of the eye, *Troglichthys* has lived in caves and done without the use of its eyes longer than any other known vertebrate."

Typhlichthys subterraneus Garman, Bull. Mus. Com. Zool., XVII, 1889, 232 (wells and caves, Jasper County, Missouri); not of Girard. Kohl, Rudimentäire Wirbelthieraugen, 1892, 59.

Typhlichthys rosæ Eigenmann, Proc. Ind. Ac. Sci., 1897 (1898), 231, **Sarcoxie, Mo.**

Troglicthys rosæ, Eigenmann, Science, N. S., IX, 1899, 280 (Day's Cave, Sarcoxie, Missouri); Degeneration in the Eyes of the *Amblyopsidæ*, its Plans, Processes and Causes, Proc. Ind. Ac. Sci., 1898 (1899), 239 (summary); Eyes of the Blind Vertebrates of N. A., Archiv. f. Entwickelungsmech., VIII, 1899, 573; A Case of Convergence, Proc. Ind. Ac. Sci., 1898 (1899), 247.

AMBLYOPSIS De Kay.

Amblyopsis De Kay, Nat. Hist. N. Y., Reptiles and Fishes, 187, 1842 (*spelæus*).

Unlike the other genera of this family, *Amblyopsis* possesses ventral fins. The eyes are concealed under the skin and are not at all functional. The head as well as the body is furnished with regularly arranged rows of tactile papillæ. Pyloric cœca generally 2, but sometimes 3.

Amblyopsis spelæus De Kay. Plate VI.

The body of *Amblyopsis* is heavier than the other members of this family; depth in length, 4 to 5; head, 3, depressed like that of *Typhlichthys;* mouth not so obliquely set as in the other members of the family; premaxillary not protractile; eye just visible through the skin in the young, not visible in the adult; gill-cavities enlarged, probably on account of the breeding habits of *Amblyopsis*[a]; pectoral contained 1.7 in head; anal rounded, with 8 to 10 rays; dorsal, with 8 to 10 rays, inserted slightly in front of anal, similar to it in shape. The variation of the rays in these 2 fins depends on the short rays at the front of each. These are very small and are covered by the fat skin, so as not to be seen from an external examination. Caudal fin broad, slightly pointed at tip; ventrals very small, inserted so that their posterior margins reach front of anal, rays about 4 in each fin. Fatty enlargements present at bases of all the fins, but more especially the dorsal, anal, and ventral; pyloric cœca 2 to 3; scales small and arranged irregularly, similar to those of *Chologaster*. Body colorless. In life the color is a rosy, purplish hue, due to the blood vessels which show through the skin; alcoholic and formalin specimens, yellowish white; no evidence of pigment anywhere on the surface. Length, 5 inches.

This species is known south of the Ohio River from Mammoth Cave and its vicinity only. North of the Ohio it has been found in a number of caves from Little Wyandotte, near the Ohio, to Hamers and Donnelsons caves, near the East Fork of the White River. It has become very rare in and about Mammoth Cave. The specimens examined were one from Mammoth Cave, a large number from Donnelsons Cave, and one from Hamers Cave.

[a] Eigenmann, Marine Biological Lectures, 1900, for 1899, 113.

Measurements.

No.	Head.	Depth.	Dorsal.	Anal.	Ventral.	Length.	Notes.
1	3	$4\frac{1}{2}$	9	9	4—4	77	Caves, Mitchell, Ind.
2	$3\frac{1}{4}$	$4\frac{1}{4}$	9	9	4—5	80	Do.
3	3	$4\frac{1}{4}$	8	8	4—4	75	Do.
4	3	$4\frac{1}{8}$	9	10	4—4	70	Do.
5	$2\frac{5}{8}$	$4\frac{1}{2}$	10	9	4—4	80	Do.
6	3	$4\frac{1}{4}$	10	9	5—4	70	Do.
7	$2\frac{3}{4}$	5	9	10	3—4	63	Do.
8	3	$4\frac{1}{2}$	9	10	4—4	79	Do.
9	$3\frac{1}{8}$	5	10	10	4—4	85	Do.
10	$2\frac{3}{4}$	4	10	10	4—4	72	Do.
11	$3\frac{1}{8}$	$4\frac{1}{2}$	9	9	4—4	62	Do.
12	3	$4\frac{3}{4}$	9	10	4—4	65	Do.
13	3	5	9	9	4—4	63	Do.
14	3	$4\frac{1}{2}$	10	10	4—4	75	Do.
15	3	$4\frac{1}{2}$	10	10	4—4	64	Do.
16	3	5	10	10	4—4	70	Do.
17	3	$4\frac{1}{2}$	9	10	4—4	70	Do.
18	3	$4\frac{1}{2}$	10	9	4—4	63	Do.
19	3	$4\frac{1}{2}$	10	10	4—4	69	Do.
20	$3\frac{1}{4}$	$4\frac{3}{5}$	9	8	4—3	63	Do.
21	3	$4\frac{3}{4}$	10	10	4—4	61	Do.
22	3	5	10	9	4—4	57	Do.
23	3	$4\frac{1}{2}$	10	9	5—4	60	Do.
24	3	5	10	10	4—4	60	Do.

Amblyopsis spelæus De Kay, Nat. Hist., N. Y., Reptiles and Fishes, 187, 1842, **Mammoth Cave, Kentucky.** Wyman, Ann. and Mag. Nat. Hist., XII, 1843, 298; Amer. Jour. Sci. and Arts, XLV, 1843, 94 to 96 (Kentucky). Thompson, Ann. and Mag. Nat. Hist., XIII, 1844, 112. Telkampf, Müller's Arch., 1844, 381 to 394, taf. 9. Wyman, Proc. Bost. Soc. Nat. Hist., III, 1850, 349 to 357. Agassiz, Amer. Jour. Sci. and Arts, XL, 1851, 127. Wyman, Bost. Soc. Nat. Hist., IV, 1854, 395, V, 18; Amer. Jour. Sci. and Arts, XVII, 1854, 258. Poey, Mem. Cuba, II, 104, 1853. Günther, Cat. Fishes Brit. Mus., VII, 2, 1868 (Mammoth Cave, Kentucky). Putnam, Amer. Nat., 1872, 30, fig. (in part). Cope, Rept. Geol. Res. of Indiana, III and IV, 1871 and 1872 (1872), 161 (Little Wyandotte Cave, Indiana); Ann. and Mag. Nat. Hist., 1872 (Little Wyandotte Cave, Indiana). Jordan, Rept. Geol. Nat. Res. of Indiana, VI, 1874 (1875), 218 (Mammoth Cave). Cope, Rept. Geol. Nat. Res. of Indiana, VIII, IX, X, 1876, '77, '78 (1878), 483 (Little Wyandotte Cave, Indiana). Jordan & Gilbert, Synopsis, 324, 1883. Packard, Cave Fauna of N. A., Mem. Nat. Ac. Sci., 1886, 14 (Hamers and Donnelsons caves, Lawrence Co., Indiana; Mammoth Cave, Ky.). Hay, Rept. Geol. and Nat. Res. of Indiana, XIX, 1894, I, 706. Blatchley, Rept. Geol. Nat. Hist. Res. of Indiana, XXI, 1896, 183 (Sibert's well cave, a part of Little Wyandotte Cave, and in caves near Mitchell, Ind.). Eigenmann, Proc. Ind. Ac. Sci., 1897 (1898), 230; Degeneration of the Eyes of the *Amblyopsidæ*, its Plans, Processes and Causes, Proc. Ind. Ac. Sci., 1899, 239 (summary). Eigenmann & Yoder, The Ear and Hearing of the Blind Fishes, Proc. Ind. Ac. Sci., 1898 (1899), 242. Eigenmann, Eyes of the Blind Vertebrates of N. A., Archiv. f. Entwickelungsmech., VIII, 1899, 545; Pop. Sci. Mo., LVI, 1900, 485; Marine Biological Lectures, 1900, for 1899, 113.

THE LIFE HISTORY OF THE BLUE CRAB (CALLINECTES SAPIDUS)

By W. P. HAY, M. S.
Professor of Biology, Howard University

THE LIFE HISTORY OF THE BLUE CRAB (CALLINECTES SAPIDUS).

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The following report embodies the results of two summers' work (1902 and 1903) in the crab-producing region bordering Chesapeake Bay. The information was gathered incidentally in connection with a thorough study of the diamond-back terrapin, and on that account is by no means as complete as could be desired. Many of the theories advanced by the fishermen and packers regarding the blue crab have not yet been subjected to close examination, although every opportunity has been taken for this purpose. In some cases the reports secured were so contradictory that it is not deemed safe to express an opinion concerning them. Quite a number of facts, however, have been brought to light, and they are here presented in the hope that they may prove valuable to those engaged in the fishery or to those whose duty it is to secure the enactment of laws to regulate and prolong it.

The fishermen and crab packers throughout the region gave most cordial cooperation to the investigations. Special thanks are due to Messrs. Tull & Co., Tawes & Riggins, and Christy Brothers, of Crisfield, Md., and to Messrs. McMenamin & Co., of Hampton, Va., all of whom rendered valuable assistance by supplying material or information.

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SYSTEMATIC POSITION.

The blue crab (*Callinectes sapidus* Rathbun) is a common and well-known crustacean along the Middle and South Atlantic and Gulf coasts of North America. It is one of the nine species which in Miss Rathbun's recent revision[a] are regarded as forming the genus, the other members of which are inhabitants of the coasts of South America, Mexico (on both the Atlantic and Pacific sides), and the Atlantic coast of Africa. *Callinectes* is one of the genera constituting the family *Portunidæ*, the members of which are commonly known as "swimming crabs," from the fact that with one exception in all the known species the last pair of legs are developed as broad paddles by means of which the animals propel themselves through the water. The family is an extensive one, but those genera which occur on the coasts of North America may be readily distinguished by the following key, which is adapted from Miss Rathbun:[b]

a. Last pair of legs broad, modified into swimming paddles.

b. Carapace decidedly broader than long, antero-lateral margins cut into nine teeth.

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[a] The Genus Callinectes, Mary J. Rathbun, Proc. U. S. Nat. Mus., XVIII, 1896, pp. 349–375, pls. XII–XXVIII.

[b] Synopses of North American Invertebrates, American Naturalist, XXXIV, Feb., 1900, p. 139.

c. Movable portion of the antenna excluded from the orbital cavity by a prolongation of the basal joint of the antenna .... *Charybdella.*
c[1]. Movable portion of the antenna not excluded from the orbit.
d. No longitudinal ridge on the palate .... *Arenæus.*
d[1]. A longitudinal ridge on the palate.
e. Abdomen of the male ⊥-shaped .... *Callinectes.*
e[1]. Abdomen of the male triangular................................ *Portunus.*
b[1]. Carapace not very broad, antero-lateral margins cut into five teeth.
c. Last tooth of antero-lateral margin developed into a spine longer than the other teeth or spines .... *Bathynectes.*
c[1]. All antero-lateral teeth similar .... *Ovalipes.*
a[1]. Last pair of legs narrow, with terminal segment lanceolate .... *Carcinides.*

Of the nine species of the genus *Callinectes* five have been recorded from the United States. They are *C. sapidus* Rathbun, *C. ornatus* Ordway, *C. danæ* Smith, *C. larvatus* Ordway, and *C. exasperatus* Ordway. Of these the first is distributed along the Atlantic coast from Massachusetts Bay to Florida and along the coast of the Gulf of Mexico, the Caribbean Sea, and the Atlantic coast of South America as far south as Brazil; *C. ornatus* Ordway has been found as far north as Charleston, S. C., and thence southward to Victoria, Brazil; *C. danæ* Smith has been collected at various localities between South Carolina and Santos, Brazil[a]; *C. larvatus* Ordway has been reported from some of the Florida keys, from Vera Cruz, Mexico, from various islands of the Bahamas and the West Indies, from the coast of Brazil, and from the West coast of Africa; *C. exasperatus* Ordway has been collected at Key West., Fla., Jamaica, Old Providence, and at several points on the coast of Brazil. In addition to these, *C. bocourti* Milne-Edwards occurs on the coasts of Central and South America; *C. arcuatus* Ordway is found in the Gulf of California and Pacific coasts of Mexico and Central America; *C. toxotes* Ordway from Cape St. Lucas to Guayaquil, Ecuador; *C. bellicosus* (Stimpson) from numerous points in Lower California and in the Gulf of California; and *C. nitidus* A. Milne Edwards from Guatemala probably to Chile.

Some of the species are very distinct, but others are distinguished with difficulty. The following key, revised from Miss Rathbun's, will serve for their identification.

a. Inner supraorbital fissure closed.
b. Front with four intraorbital teeth .... *C. sapidus.*
b[1]. Front with six intraorbital teeth.
c. Verges much shorter than the abdomen.
d. Lateral spine more than twice the length of preceding tooth.
e. Intramedial region broad, its anterior width about three times its length .... *C. ornatus.*

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[a] The occurrence of *C. sapidus* in a fresh water basin at Rochefort, France, recorded by Bouvier (Bulletin Musee Paris, VII, 16), is, as that author suggests, to be regarded as entirely accidental, the specimen having been carried across the Atlantic in some vessel.

e^1. Intramedial region narrow, its anterior width about two times its length.
  f. Verges greatly exceeding the third segment of the abdomen.
    g. Tips of verges straight. Second to sixth antero-lateral teeth equilateral .... *C. danæ.*
    g^1. Tips of verges curved. Antero-lateral teeth with posterior margins longer than anterior .... *C. arcuatus.*
  f^1. Verges exceeding the third segment but little, or not at all .. *C. larvatus.*
d^1 Lateral spine less than twice the length of preceding tooth ...... *C. exasperatus.*
c^1. Verges reaching the extremity of the abdomen or nearly so.
  d. Antero-lateral region granulate. Lateral spine between two and three times length of preceding tooth .... *C. toxotes.*
  d^1. Antero-lateral region smooth. Lateral spine less than twice the length of preceding tooth .... *C. bocourti.*
a^1. Inner supraorbital fissure open .... *C. bellicosus.*

Toward the southern half of its range the true *C. sapidus* is more or less replaced locally by a varietal form, *C. sapidus acutideus* Rathbun, which differs in the possession of an accessory tooth on the inner margin of each of the pair of median frontal teeth. This form begins to appear in the Gulf of Mexico and is apparently common on the coast of Cuba and probably other of the West Indian Islands.

DISTRIBUTION AND HABITAT.

The natural range of the blue crab is from Massachusetts Bay to some as yet undetermined point on the east coast of South America. On the coast of the United States it is common from Cape Cod to the southern extremity of Texas, and throughout the greater portion of this long coast line it is very abundant. Its favorite habitat is in the waters of some bay or at the mouth of a river, and it seems to prefer shallow water to that of much depth. Consequently, such bodies of water as Delaware Bay, Chesapeake Bay, and the protected channels along the coasts of Virginia and other South Atlantic and Gulf States fairly swarm with these creatures. Chesapeake Bay is especially favorable and has long been famous, not only for the great number of crabs which it produces, but also for their large size and exceptionally fine flavor.

Although the blue crab is essentially an inhabitant of salt water, it is frequently found in water that is only slightly brackish or even apparently quite fresh. Specimens have been recorded from the Hudson River as far north as Newberg and on credible authority I have learned of the presence of an occasional individual in the Potomac River and the Eastern Branch opposite the city of Washington. At Crisfield, Md., and at other points along both the eastern and western shores of Chesapeake Bay, I have frequently observed the blue crab in ponds and ditches, often at a distance of a mile or two from the bay and in water that was nearly fresh. In such situations it was often living in shallow burrows in the banks, but I was unable to determine whether these were of its own construction.

Within the larger bodies of water the crabs are quite generally distributed—that is to say, individuals are not uncommon anywhere, but there are certain localities where their abundance is almost incredible and the supply seems inexhaustible. These favored spots seem to be the mud bottoms such as are to be found near the mouths of the larger rivers, in shallow water where there is an abundance of vegetation. Hard bottoms, oyster beds, or bottoms consisting of soft ooze without vegetation are apparently not best suited to their welfare, for on such spots comparatively few crabs are to be found.

The habitat varies considerably with the season. In the summer the crabs live close to the shore; in the winter they move into deeper water. It would also seem that the habitat varies somewhat with the age and sex of the individuals, for even in the summer the small and medium sized crabs are most abundant in shallow water, while the large males remain in the deeper channels.[a] An examination of the crabs from shallow water shows that small males and virgin females constitute the bulk of the catch.

POWER OF MOVEMENT.

Either in the water or on land the blue crab is an animal of great activity and has considerable power of endurance. Progression through the water is effected by means of a sculling motion of the broad, oar-like posterior legs, and under ordinary conditions is slow, the effort of the animal being apparently only to keep itself afloat while it is borne along by the current. Under these conditions the movement is either backward or sidewise. The shell is held with the posterior portion uppermost, the legs are brought together above the back and strike backward and downward at the rate of from 20 to 40 strokes per minute. When alarmed, however, the animal strikes out with great vigor and rapidity, moving its paddles too swiftly for the eye to follow; it moves through the water almost as rapidly as a fish and quickly sinks below the surface. When on the bottom and undisturbed, the crab may be seen to walk slowly about on the tips of the second, third, and fourth pairs of legs, the large pincers being held either extended or folded close under the shell and the paddles either raised and resting against the back of the shell or assisting the movement by slow sculling strokes. In such cases the movement is in any direction—forward, backward, or sidewise—although the usual direction is sidewise. If the animal becomes alarmed it moves away by a combination of the walking and swimming motions and often disappears like a flash. In fact, so rapid is the movement that it is almost impossible to see how it is accomplished. It is too steady and uniform

[a] This fact is well known to the fishermen, who frequently refer to these large males as "*channellers.*"

to be a series of leaps, and the animal seems too far above the bottom to be running upon it; yet all the legs are in motion except the large first pair. Of the latter, the one on the side toward which the animal is moving is held straight out sidewise, while the other is folded up under the shell.

METHOD OF CONCEALMENT.

The coloration of the crab is such as to harmonize very perfectly with the surroundings, and the animal attempts very little concealment if there are other objects on the bottom. Often, however, a clear, sandy bottom or some oozy pond will be found to be almost alive with crabs which have buried themselves until only their eyes and their antennæ are exposed. In thus hiding, the crab goes nearly vertically backward into the bottom and then, by a few movements, turns slightly, so that the shell rests at an angle of about 45°. The material above settles down and effaces all traces of the entrance. It usually happens that the bottom affected by the crab is firm enough to render this operation somewhat slow and it rarely attempts to escape pursuit in such a way. It seems probable that concealment is usually adopted as an ambush from which a sudden attack can be made on some passing fish.

In certain places, notably shallow ponds and streams which become nearly dry at low tide, the crab may be observed to dig rather large, conical holes, apparantly as reservoirs, and to take up its position in the deepest part. The work of making such an excavation often requires two or three hours, usually commencing soon after the tide has begun to ebb strongly and continuing until the edge of the excavation is nearly exposed above the water. The animal works from some suitable point, carrying away load after load of material clasped between the large claw and the lower surface of the front of the shell. It loosens up the surface with the tips of its second, third, and fourth pairs of legs, grasps all it can carry, and then moves off a few inches in the direction of the side which bears the load and deposits it so that it will not roll back. Thus the hole is gradually deepened and the surrounding circle built up and widened until it has a breadth of about a foot, with a depth of perhaps 6 inches. The crab then settles itself into the sand or mud at the bottom of the hole and waits until the rising tide offers an opportunity to move about again.

The blue crab has very seldom been seen to come out on land voluntarily, although it is able to sustain life for several hours when removed from the water. In low, swampy situations I have occasionally seen an individual moving about in the dense grass or hanging to the grass just above the water, and in Miss Rathbun's paper "The Genus Callinectes," there is a description by Mr. Willard Nye, jr., of the migration of a large number of crabs from a small pond to the

ocean over a beach 400 feet wide. They had been imprisoned in the shallow water and were forced by cold weather to make the excursion to deeper places.

During the molting periods the crab will always hide itself, if possible, under some submerged timber, rock, or bunch of grass. Here it will remain quietly until after its shell has been shed and the new shell has hardened.

The color of the crab is more or less variable, and it is believed by the fishermen that the animal is able to change its hue slightly to approximate the color of its surroundings. Light grayish-green individuals are said to be taken on sandy bottoms, while the dark olive-green are said to be found among the grass. This theory, however, is not very well borne out by crabs held in captivity in the live boxes, for there they retain their original colors, and even after they have cast their shells exhibit quite as much variety as before.

FOOD.

The blue crab's food is of a varied character, but the animal is preeminently a scavenger and a cannibal. In the shallow waters of ponds and small tidal streams it preys to a certain extent upon small fish, which it stalks with some cunning and seizes by a quick movement of its large claws. In such situations, too, I have sometimes observed it nibbling at the tender shoots of eel grass or other aquatic vegetation, or picking at the decayed wood of some sunken log. Its favorite food, however, is the flesh of some dead and putrid animal, to obtain which it will travel a considerable distance from its hiding place. A piece of stale meat or a rotten fish will attract the crabs for several yards around and they will swarm over the morsel until it is entirely devoured. The offal from stables and water-closets which project over the water furnishes the crabs with many a meal and in such spots numbers of the animals may be observed lying in wait for food.

Wherever crabs are abundant they constitute a source of great annoyance to fishermen, for they are adepts at stealing bait from the hooks and will return time and again after having been drawn to the surface of the water and apparently frightened away.

An injured crab, if thrown into the water, will be speedily set upon by its associates and torn to pieces. Even one that is uninjured, if small or in the soft-shelled condition, is likely to be captured and eaten by stronger individuals.

In eating a bit of food the crab first grasps it in the large claws and pushes it back under the front of the shell, where it is seized between the tips of the second pair of legs and pushed forward and upward to a point where it can pass between the third maxillipeds to the jaws. These strong organs masticate the food while the other mouth-parts prevent the escape of the smaller particles. It is then swallowed and

the complicated set of teeth in the stomach reduce it to a thin fluid mass before it is allowed to pass into the intestine.

Digestion in the crab seems to be a rapid process, for the food disappears so quickly from the stomach that this organ is usually found to be perfectly empty within a few minutes after having received a full meal. It is a common idea among the fishermen that food is not retained in the crab's stomach at all, but this I have disproved by numerous dissections.

REPRODUCTION.

The sexes of the crab are separate, and reproduction is effected by means of eggs, which are laid by the female after copulation. The male crab may instantly be recognized by its narrow ⊥-shaped abdomen, or apron, which is folded under the cephalo-thorax and lies over a rather deep groove in the sternum between the second, third, and fourth pairs of legs. (Fig. 2, pl. I.) Its base is broad and nearly fills the space between the fifth pair of legs. The verges, or intromittent organs, consisting of the much modified first pair of abdominal appendages, lie within the sternal groove and are ordinarily completely hidden by the abdomen, but are easily exposed by raising that portion of the animal's body. The male is also usually distinguishable by its larger size and the greater amount of blue on its legs and the lower surface of the body. The soft-shelled male shows a good deal of blue on the back also, but as the shell hardens this gives way to the usual dull gray green.

Among the female crabs two distinct forms are recognizable, which we may designate, respectively, as virgin and ovigerous forms. In both the body is more tumid and the abdomen is much broader than in the male. In the virgin form the abdomen has a triangular shape, the sides converging nearly uniformly from the base to the tip. (Fig. 3, pl. II.) In the ovigerous form it is nearly semicircular in outline, except for the small terminal segment, which projects in front as a small triangle on the middle line. (Fig. 4, pl. II.) In the virgin form the abdomen lies, as in the male, in a depression between the bases of the last four pairs of legs, but it is fastened in its place so strongly, by means of a pair of hooks which project from the body and fit into a pocket on each side of the abdomen, that it can hardly be raised without being broken. The swimmerets on such an abdomen are small—almost rudimentary—and would hardly be noticed in a cursory examination. In the ovigerous form, on the other hand, the abdomen covers nearly the whole lower surface of the shell, even overlapping the basal segments of the last four pairs of legs, and it is held in position only by a muscular effort on the part of the animal. When such an abdomen is lifted up, the observer is at once struck with the large size of the swimmerets, which, with their fringes of hairs, entirely fill the space between the abdomen and the shell of the body. It will further be

observed with regard to these two forms among the females, that the first, or virgin form includes all the smaller individuals, while the second, or ovigerous form includes only those of larger size. That the condition is not an evidence of age, however, will be shown further on.

Crabs may be found pairing at almost any time during warm weather, but there seem to be five or six periods between early June and the beginning of cold weather when the act is at its height. During these times mated crabs, "doublers," as they are called by the fishermen, are found in considerable numbers, either lying on the bottom in shallow water or swimming at the surface. It appears that the male crab is able to distinguish the female which is about to shed her shell, and having found such a one seizes her and carries her about with him, sometimes for a day or two, until the shedding of her shell is imminent. He then places her in some sheltered place and stands guard over her ready to repel the advances of any other male. At this time the female invariably is of the virgin form, and copulation has not taken place. When she sheds her shell, however, she has passed into the ovigerous form, the broad semicircular abdomen of her new condition having been withdrawn from the shell of the narrow triangular abdomen of the virgin form. She is now ready for copulation, and is immediately approached again by her mate. She turns back her abdomen, thus exposing the openings of her oviducts, the verges of the male are inserted, and she is grasped by the tips of his second, third, and fourth pairs of legs, and carried away. In the mated crabs the female, before she has cast her shell, is carried by the male with her back against his ventral surface; during copulation her position is reversed. Copulation lasts for a day or two, coming to an end as soon as the new shell of the female has hardened. The pair then separate, and so far as is known pay no further attention to each other.[a]

The female is now ready to produce her eggs, and for this act it seems that she seeks the ocean or the mouth of some large bay. In Chesapeake Bay mating crabs are abundant at least as far north as Annapolis, but a crab with eggs is very seldom found there. On the other hand, at Cape Charles City, Va., at Hampton, Va., and neighboring points, egg-bearing females are far more abundant than either males or virgin females during the latter part of summer, but apparently do not often come into shallow water. All the individuals seen at the two Virginia localities had been caught on trot lines. An exactly

[a] Although the facts cited in the last few paragraphs are matters of common knowledge among the crab fishermen, I am not aware that their relation has been recorded in any of the printed accounts of this animal. The fact that copulation is possible only while the female is in the soft-shelled condition has been noted by several observers, and that about the time of copulation she changes from the narrow abdomened to the broad abdomened form is mentioned on page 369 of Miss Rathbun's paper.

similar condition of affairs has been reported by Paulmier to obtain at the Long Island fisheries. He says:

The investigations of the writer, finally, failed to show any in the shallow waters of the bays and rivers. It thus seems certain that the crabs in berry do not come into the shallow water at any season in the north.

During the latter part of June, however, a few specimens were taken while clinging to a pound net near Fire Island inlet in about 20 feet of water. For the next three weeks none were seen, while small males were quite common. Then the females suddenly appeared in great numbers on the nets, but, as mentioned, none were seen on the shore.

The eggs of the crab are very minute, about $\frac{1}{100}$ of an inch in diameter, and they are very numerous, it having been estimated that a single female may produce as many as 3,000,000. As soon as the eggs are laid they adhere to the fringes of hairs on the swimmerets and form a mass which is nearly a third as large as the female's body. They are carried about thus until they hatch, when the young, after clinging to the mother for a short time, loosen their hold and begin a free existence.

The eggs are probably produced soon after copulation, consequently among the great mass of crabs there are to be found some "blooming females" throughout the summer wherever conditions are favorable for egg laying. The majority spawn in the fall or early spring. In his article on the blue crab (Fisheries and Fishery Industries, p. 642, 1880) Mr. Richard Rathbun states that at Hampton, Va., in 1880, the first crabs with eggs were taken on the first of March, but they do not appear usually until April. The height of the spawning season is from May to August, though many egg-laden crabs are seen until November. At Charleston, S. C., in March of the same year, Mr. R. E. Earll reported that at least two-thirds of the catch were females, laden with eggs which from their immature condition would probably not hatch before April or May. In this connection is quoted the following letter from Mr. S. L. Addison, of McMenamin & Co., crab packers at Hampton, Va.:

The proportion of the male and female crabs varies considerably during the year, but the average is about two males to twelve females. Egg-bearing females are most abundant during the hottest part of the season. As to what time the eggs hatch and how soon after laying, we have no means of ascertaining, and exactly what becomes of the young is a hard question to answer, although the very small crabs are found at all times of the year. Very many of the small crabs are devoured by fish and oysters. We have no reason to believe that the female dies after she spawns. On the contrary, we are satisfied that she does not, as her appearance gives every evidence of it. We are not able to state how long it takes a crab to grow from the egg to maturity, and, in fact, do not know at what age it is mature.

Our oldest crabber, who has been in the business for about twenty years, says positively that every crab sheds its shell once every three months during the whole year, both winter and summer.

Very many egg-bearing female crabs are caught for market and canning purposes, and we see no way to prevent this, as they do not all spawn at the same time, but

during the whole season some of them are spawning. Our experience is that we find more of the small crabs about March and April, although, as we stated above, some of them are found during the entire season. From the best information, nearly all the crabs, if not all, spawn in the rivers and afterwards come into salt water. We do not think they travel from this section northward, but, on the contrary, we think they generally come southward.

Our opinion is that there is nothing so detrimental to the crab industry as dredging for crabs in winter time, and what makes us feel so sure of it is the fact that after they are dredged in a certain location in the winter, the next season none or scarcely any of them are to be found there. They will not bed in the same place the succeeding winter.

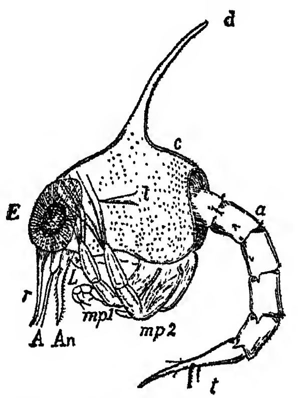
We are borne out in the opinion by our oldest and best crabbers, that generally about June and July we have a little different crab reach us here in Hampton Roads, which is generally called the ocean crab. It is larger than the one which we get earlier in the season, and is a much bluer crab. We can not say whether this crab comes from the north or south to us.

Mr. Isaac H. Tawes, of Crisfield, Md., reports as follows:

From what I can learn, the crabs spawn in the spring. I have been noticing them for several years. I always see the small baby crabs in May and June. I think the females mature during the winter and spawn in the spring.

METAMORPHOSIS AND SUBSEQUENT GROWTH.

The young crab when it first escapes from the egg is almost microscopic in size and of a very different appearance from the adult. It is known as a zoæa larva.[a] It has a swollen, globose body and a long, slender, segmented tail. The eyes are especially large and prominent and are borne on short, thick stalks. The shell which covers the head and body is prolonged downward between the eyes to form a long, slender, pointed rostrum (cuts 1 and 2, *r.*). On each side, near the middle of the shell, there is a smaller lateral spine (cut 1, *l.*) and near the middle of the back there is a long, slender, curved spine (cut 1, *d.*). The tail or abdomen, which afterward becomes the "apron" of the adult crab, is longer than the body and is composed of six cylindrical segments; it bears no appendages and ends in a large, forked telson (cuts 1 and 2, *t.*). The tail is movable and assists the animal in swimming. At the front of the body, in the neighborhood of the mouth, there are

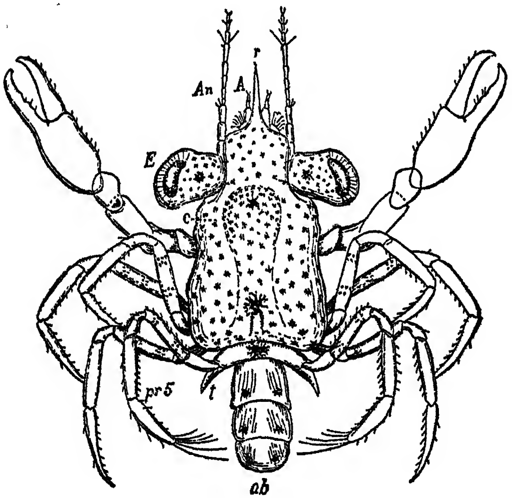


CUT 1.—Zoæa form of *Callinectes sapidus* or some closely related crab. (After Brooks.)

[a] The following account of the metamorphosis of the crab and the figures which accompany it have been taken from Dr. W. K. Brooks' Handbook of Invertebrate Zoology (S. E. Casino, Boston, 1882), with such revisions as have been necessary to adapt it for popular reading.

seven pairs of appendages, which are usually designated as the first and second antennæ, the mandibles, the first and second maxillæ, and the first and second maxillipeds, the latter being provided with long plumose hairs and used as the principal organs of propulsion as the animal swims through the water. The other thoracic appendages of the adult crab—namely, the third maxillipeds and the five pairs of legs—are represented only by a series of buds lying on each side, almost concealed by the shell. The shell itself is very thin and so transparent that the heart, the intestine, the muscles which move the appendages, and all the other internal organs may be easily observed.

The zoœa sheds its shell a number of times, the bud-like rudiments of the third maxillipeds and the legs grow a little and the portion of the body which carries them becomes obscurely divided into segments. The abdominal feet or swimmerets make their appearance as pairs of buds on the ventral surface of the abdominal segments, and certain changes occur in the antennæ and mandibles which cause these parts to resemble more closely the parts of the adult crab.



CUT 2.—Megalops form of *Callinectes sapidus* or some closely related crab. (After Brooks.)

For a number of molts the change of the larva is gradual, but after a time it sheds its shell and becomes suddenly converted into a form which is quite different from the zoœa, and which is known as a megalops. The megalops differs from the zoœa in the following characters:

(1) There are no lateral spines and the dorsal spine is very short.

(2) The eyes are at the ends of very movable stalks.

(3) The five pairs of legs are fully developed and are very similar to those of the adult.

(4) The gills have made their appearance above the bases of the legs, under the margins of the shell, but these margins are still free.

(5) The maxillipeds are no longer organs of locomotion and there are three pairs.

(6) While the larva is still able to swim, it also moves over the bottom by walking upon the tips of its legs, with a crab-like gait, very

similar to that of the adult. A reference to the figure, however, will show that the megalops is still far from being like the adult crab. There is still a long-pointed rostrum on the front of the shell, and the eyes, instead of being hidden in cavities on the front of the shell, project conspicuously from the sides at the base of the rostrum. Both pairs of antennæ project from beneath the rostrum, and the lash of the second antenna is very long. The last pair of legs are bent upward and backward above the back of the shell and are borne on a separate, movable segment of the body. The abdomen is still long and carries five or six pairs of swimmerets; while the animal is swimming the abdomen is stretched out behind the carapace, but while crawling it may be bent forward under the ventral surface of the body, as in the adult. The third pair of maxillipeds are still leg-like, being composed of cylindrical segments, and are not flattened as ir the adult. In fact the general structure and appearance are quite as much like that of a crayfish or lobster, as like that of the familiar blue crab.

The time required for the megalops larva to change into a young crab having the form of the adult has not been recorded, but is probably quite short. By successive molts[a] the outline of the shell, the structure of the appendages, and the internal anatomy approximate more and more closely the future condition, until at last, by the time the animal has reached a breadth of perhaps one-fourth of an inch, its true nature becomes plainly evident.

Even before this time it has fallen in with others of its kind and together with them it moves shoreward.[b] In Chesapeake Bay this general shoreward movement appears to take place early in the spring, for at Crisfield in April, and to some extent in May, the tiny crabs begin to appear in great numbers. They float along with the currents, clinging to bunches of grass or swimming freely in the water, and finally find a suitable home in some shallow and sheltered bay or

[a] The number of molts during the megalops stage is stated by Paulmier to be (probably) six.

[b] In Miss Rathbun's paper (p. 368) there is given an account by Mr. John D. Mitchell, of Victoria, Tex., of the breeding habits of the crab in the Gulf of Mexico. He says: "The eggs begin growing in the spring and hatch the latter part of May or June, the young clinging to the apron for several days. When first hatched they are very little more than two eyes, and look like anything but a crab. I know little about the number of times the young sheds from the time of leaving the mother's apron until it gets its crab shape, which is inside of three months. I have seen the little fellows so thick near the margin that the water would look murky and thick, and thousands could be scooped up in the two hands placed together, and their cast-off shells would form a gray streak along the water's edge. They collect in immense numbers along protected shores and nooks, shedding several times and getting their shape in September, when they start on their great migration across the bays for the north shores, where they enter the creeks and estuaries, and go upon the shoals, where they remain until grown, burying themselves in the mud and sand in winter."

estuary. These young crabs have almost certainly hatched from the egg the preceding fall, for it is then, in the months of August and September, that egg-bearing females, "blooming crabs," in the fishermen's vernacular, are most abundant in the extreme lower part of the bay.

Once having established itself in a congenial location, the young crab probably remains there until it has attained its growth. It has been stated that three years is required for this[a] and that the young crab sheds its shell twice each summer before it reaches its full size. It is quite possible, however, and such evidence as I have been able to collect makes it seem probable, that in Chesapeake Bay, at least, the growth of the young crab is more rapid and that it may reach its full size in at most two seasons. At Crisfield, where hundreds of thousands of crabs are taken each summer and sent to market, the spring catch, beginning in May, contains great numbers of small crabs from 1½ to 2 inches across. By the next month they have reached 3 inches, and in July individuals 4 inches across are the rule. In August and September most of the females have reached a breadth of 5 inches and are mature and ready for mating. It may be, of course, that this gradual increase in the size of the individuals taken does not prove such a rapid growth so much as an increased number of crabs on the bottoms from which the fishermen can choose. There are always a certain number of small crabs taken in the nets and thrown back into the water again, but the number of small ones diminishes as the number of large ones increases toward the end of summer.

The duration of life of the crab after it has reached maturity is not positively known, but it is very probable that it differs somewhat in the two sexes. One observer, quoted by Miss Rathbun, gives seven years as the limit of the crab's life without regard to sex and also says that it does not molt after having reached maturity. The latter statement is probably correct, but the former can hardly be accepted without proof. The evidence which has been collected seems to show that the males will survive at least one winter and possibly two, for large, full grown individuals are common throughout the winter and in early spring and are often caught by the oyster dredgers. These large males do not shed their shells and are usually battered and more or less covered with barnacles and even oysters. The females, on the other hand, probably die soon after spawning, and therefore survive the first winter only in case they have not copulated immediately upon becoming mature. The evidence to support this statement is perhaps not wholly satisfactory. No one has, as far as I know, followed the female crabs actually to see what becomes of them, but I have been informed that at times the beaches along the lower part of the

[a] Rathbun 1896, p. 369; also Paulmier 1901, p. r. 135.

bay and the adjacent ocean are covered with dead crabs, mostly ovigerous females. All the observers mentioned the late fall as the time of such an occurrence. Moreover all those engaged in the crab fishery unite in saying that they have seldom, if ever, found an ovigerous female shedding her shell, and that the females which are found early in the season are of the virgin form. Evidently all the large females of the early spring are such as did not find a mate during the preceding season and have, therefore, still to fulfill their maternal destiny. It has been stated by Paulmier (1901) that the female crab does molt again after the eggs are hatched. His investigations made in the neighborhood of Long Island may indicate strikingly different life histories for northern and southern crabs, for the observations made at Crisfield prove quite conclusively that the female does not cast her shell after having produced her first and only lot of eggs.

MOLTING.

In practically all the lower animals whose bodies are incased in a tough unyielding covering extension in size and any change of form occurs not gradually and continuously, but suddenly and at intervals, and is always preceded by the casting off of the confining skin or shell, a process known as molting or ecdysis. The molting of the crab might have been dwelt upon more fully in the preceding paragraphs, but it is a matter of such interest and of such vital importance that it deserves to be considered by itself. It must suffice, however, to describe the process in the fully formed crab, and leave the subject of the larval molts for future investigation.

As the crab approaches the shedding period it begins to show its condition by various external "signs," which are well known to the fishermen and are of great importance to them. The first indication is a narrow white line which appears just within the thin margin of the last two joints of the posterior pair of legs. This line is so narrow and so obscured as to be barely visible, but it is immediately detected by the expert, and the individual bearing it is classed as a "fat crab," or more vulgarly as a "snot." Within three or four days the white line gives way to an equally narrow and obscure red line, and a set of fine white wrinkles makes its appearance on the blue skin between the wrist (carpus) and the upper arm (meros). Such a crab is known as a "peeler," and may be confidently expected to cast its shell within a few hours. As the time progresses the marks become more and more evident, and a reddish color (especially in virgin females) begins to appear at the margins of the segments of the abdomen. Then, on the under surface of the carapace, extending from the neighborhood of the mouth around the sides and backward to the posterior margin, there appears a narrow fracture, so that the whole upper surface of the shell can be raised up from the back like

a lid, to expose the soft body beneath. Such a crab is termed a "shedder" or a "buster." (Plate III.) At this time the animal usually lies motionless, but if disturbed is still capable of movement, and may crawl or swim slowly away. It is incapable of showing any great muscular force, however, and can inflict only an insignificant pinch with its claws.

The actual casting of the shell is now a matter of only a few minutes; a quarter of an hour will usually suffice, though the operation may be prolonged to three or four times that period if the crab is disturbed or if it is suffering from some recent injury. In the latter case it is often unable to complete the process and dies. By convulsive, throbbing movements the hinder pair of legs begin to be withdrawn from their encasement and are finally freed. Meanwhile the other legs have been started out and the body has begun to protrude more and more from the shell. At last everything is out except the front of the body and the large claws, but the latter, on account of the great discrepancy between their size and that of the narrow articulations through which they must be withdrawn, require some further effort before they can be freed. The thing would hardly be possible at all were it not for the fact that on the upper surface of the large segment of the arm (meros) a broad triangular surface of the shell becomes loosened and rises up like a flap to make way for the crowded tissues within. Some of the hard shell of the other lower (proximal) segments also seems to become softened and elastic so that by a steady pull the great pincers are finally drawn through. Thus the crab has backed out of its shell and meanwhile it has grown, for if it is caught and measured it will be found to be considerably larger than it was before.[a] (Plate IV.)

The skin is soft and the animal looks and feels flabby and helpless. The back is wrinkled, and the "horns," or large lateral spines, are curled curiously forward. Within a few minutes, however, the body fills out, the horns straighten, and the growth at this interval is com-

[a] The following measurements will show the increase in size for crabs nearly mature. The specimens were taken from floats at Crisfield and were selected at random from among a large number. An effort was made to secure measurements of smaller individuals as well, but the lateness of the season made it impossible.

Sex.	Before shedding from tip to tip across the shell.	After shedding.	Sex.	Before shedding from tip to tip across the shell.	After shedding.
	Inches.	*Inches.*		*Inches.*	*Inches.*
Female	4½	5½	Female	4	4⅝
Do	3½	4½	Do	4	5
Do	3⅝	4⅝	Do	3 15/16	5 1/16
Do	4¼	5⅛	Male	3⅝	4¼
Do	4	4¾	Do	3⅝	4⅛
Do	5¼	6⅛			

plete. The crab is now known as a "soft-shell," and from the æsthetic standpoint is at the height of its glory, for all the brilliant coloration of the various parts is undimmed by any of the shell deposits, the soft integument seeming to bear the bright pigments at the very surface.

Under natural conditions the crab usually selects some place of concealment in which to pass the period of shedding and probably does not leave it until the new shell has hardened, but it is by no means helpless, even immediately after ecdysis has occurred. On the tips of legs which seem too soft to support any weight whatever it can walk away, or, if forced to make the effort, can swim. The new shell hardens quickly. Within twelve hours it becomes parchment-like and the crab is called a "buckler," "buckram," or a "bucklum;" in two or three days it is as hard as ever and once more starts out in search of food.[a]

AUTOTOMY.

Autotomy, or the automatic throwing off of the appendages, is very characteristically shown in the blue crab and is of frequent occurrence. Very often if a large individual, in the hard-shelled condition, is captured and held by one leg it will snap the limb off and make its escape. Likewise, if one of the legs is injured toward the tip the entire member will be dropped off. The breakage always occurs at the same point—across one of the segments near the base of the leg—and is a provision of nature to prevent the animal from bleeding to death. It is practiced ordinarily only by the hard-shelled crabs; an injury to a soft-shelled individual usually causes death. Under other conditions, however—notably, a sudden lowering of temperature—the act has been observed, and in one of the early attempts to procure soft crabs for market, by confining the hard crabs in an inclosure until they had shed their shells, severe cold weather reduced the entire catch to a lot of legless bodies ("buffaloes," they are called by the fishermen).

Autotomy seems to be limited to the legs, for, so far as I have been able to determine, none of the other appendages are ever thrown off, although if they are forcibly removed they will be regenerated.

Regeneration of the parts cast off usually follows autotomy, but, according to the researches of several biologists, will not take place indefinitely. Three or four times seems to be the limit. The process of regeneration is quite rapid. At the first molt after a limb has been cast off, provided that the injury does not occur immediately before a molt, the new limb appears as a small bud in which all the missing segments may be found, coiled in an elongate spiral. At the next molt the segments straighten out and the new limb, except for its smaller size, looks like the one which was cast off. Another molt, possibly two, will be sufficient to restore the limb to its full size.

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[a] It is believed by the fishermen that the molting of the crabs is influenced largely by the moon and the tides, but the evidence to support this theory is very contradictory.

THE CRAB INDUSTRY OF MARYLAND

By WINTHROP A. ROBERTS
Agent of the Bureau of Fisheries

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INTRODUCTION.

Maryland furnishes by far a larger supply of crabs than any state in the Union, and it is not improbable that its people were the first to discover the edible qualities of this crustacean and its value as a market product. The only species taken in the commercial fisheries of the state is the blue crab (*Callinectes sapidus*), which is caught and marketed in both the hard-shell and the soft-shell condition. The fishery for soft crabs, however, is much more extensive than that for hard crabs.

Most of the data in this paper were collected by the writer during an investigation of the fisheries of Maryland in 1902, when the entire crab-producing region of the state was visited and most of the fishermen and dealers interviewed. Prof. W. P. Hay, of Howard University, who was at that time engaged in an investigation of the natural history of the crab, collected also data concerning the fishery, and his notes have been freely used in this report. It has been the purpose not to deal with the crab from a scientific standpoint, but accurately to present the information obtained relating to its economic value.

Acknowledgment is made to the crab fishermen and dealers in this region for courtesies rendered, and especially to Mr. Isaac H. Tawes, of Crisfield; Mr. Harris, of the firm of H. L. Harris & Co., of Cambridge; Mr. Frank L. Corkran, of Oxford, and Mr. Moses E. Pritchett, of Bishops Head, all of whom contributed much valuable information.

THE SOFT-CRAB INDUSTRY.

The greatest crab shipping point in the United States is Crisfield, Md., situated near the extreme lower end of Somerset County on the Little Annemessex River, a tributary of Tangier Sound. This town not only receives the catch taken from Maryland waters in its vicinity, but also the principal part of the Tangier Island catch. Deal Island ranks next to Crisfield as a shipping point, but it has the benefit of steamboat transportation only, while Crisfield has train service in

addition. Practically all of the catch in the other crabbing localities of the state is sold to shippers at these two places. The principal grounds are Tangier Sound and tributary waters, Kedge Straits, and Holland Straits. Crab fishermen usually return from the fishing grounds daily to market their catch. In many cases, however, the distance prevents this and they are forced to live in shanties on the shores in the vicinity of the fishery, their catch being disposed of to buy-boats or crab-houses near by. As many as six men sometimes live throughout the season in a shanty which has cost about $25. Others live aboard their boats.

Apparatus.—Soft crabs are taken with three forms of apparatus—scrapes, scoop nets, and small seines. A few also are taken incidentally on trot lines, together with hard crabs, as will be mentioned in connection with the latter fishery. The catch by seines is insignificant compared with that by scrapes and scoop nets.

The scrapes used for crabbing are similar to the oyster dredge, except that they are lighter, have no teeth on the front bar, and have a cotton instead of a chain bag. Scrape frames are usually sold by weight, the price being from 7 to 10 cents a pound and the weight from 25 to 35 pounds each. The average price for a scrape, including bag and line, is about $3.50. Most of the scrape frames are made at Crisfield and Deal Island, while the netting comes from Boston and is made into bags by L. Cooper Dize, of Crisfield, who holds a patent on the bag in general use. The patent consists of a cord running along the back of the bag to keep it stretched. The width of a scrape varies from 2 feet 6 inches to 3 feet 6 inches, though few of the latter size are used.

The bags originally used were 3 feet deep, but deeper ones were found more effective in preventing the escape of the crabs, and 4 feet is now the usual depth. The same apparatus is occasionally used both in dredging for oysters and scraping for crabs.

A scoop net, or dip net, as it is sometimes called, consists of a circular bow of iron, with a cotton bag from 6 to 8 inches deep knit around it, and a handle about 5 feet long.

The seines are from 40 to 50 feet long and are hauled by two men. Crabs taken in scoop nets and seines are less mutilated than those caught in scrapes, and consequently command better prices.

Scrapes are used exclusively upon sailing vessels, and, like oyster dredges, are drawn over the bottom while the boat is moving under sail. The boats vary in size from the smallest used in dredging for oysters to 9 tons net tonnage, which was the largest size used during the season of 1901. From two to four scrapes are carried on each boat, four being exceptional, however, and only on the larger size vessels. As a rule there are two light scrapes and one heavy one to a boat. With a good breeze a crew of two men can manipulate two light scrapes,

but with a light wind the two men together handle a heavy one. A crew of three men can, with a favorable breeze, handle three scrapes at the same time. It is the object of the scraper to have the boat get sufficient headway to go slightly faster than the crabs can travel, so that they can not escape when once in the bag. Scrapes are not allowed to sink in the soft bottom, as the mud covering the bottom of the bag would furnish a means of escape. The scrapes are taken aboard every few minutes, or after covering from 75 to 200 yards, and the contents are emptied out and sorted over, usually on a board platform or broad flat trough conveniently located at the side of the boat. The bulk of the material brought up is grass and mud, from which the crabs are picked out and distributed in the several receptacles provided for them, according to the successive stages of their development.

Scrapers endeavor to reach the crabbing grounds as early in the morning as possible, before the crabs are moving about and have become scattered. The best catches are made between daylight and 10 o'clock in the forenoon, and between 3 o'clock in the afternoon and evening. The bright sun in the forenoon drives the crabs back into their holes until hunger forces them out again in the afternoon. On cloudy days they remain out much longer.

Season.—The soft-crab season extends from the first of May to the last of October, but a majority of the crabbers discontinue fishing in September to engage in oyster tonging. During the first two or three weeks of May they follow what is known as "mud-larking," that is, scoop-netting in marshes and along the banks of small streams, the crabs being found in the mud at this season of the year. By the first of June the crabs become more active and the season is then considered at its height. The heaviest catches are made during June and July. Scoop-netting is followed throughout the season, but little scraping is done after the middle of July, owing to the calm weather. Very often a fisherman will begin scraping early in the day, and when the wind has ceased anchor his sailboat and use his skiff for scoop-netting in shallow water. In some localities the bottom grass grows so thick that the scrape bag fills with it and prevents the crab from entering. The scoop net is then brought into service. In water less than 3 feet deep it is a common occurrence for the crabbers to leave their skiffs and wade out after the crabs with scoop nets.

Designations of a crab.—There are six stages of a crab's life, commonly classified as follows: First, the "hard crab," or one in its natural condition; second, a "snot," or one that has just entered the shedding stage; third, a "peeler," when the old shell has begun to break; fourth, a "buster," when the new shell can be seen; fifth, the "soft crab;" sixth, a "paper-shell," or "buckram," when the new shell is beginning to harden. During hot weather it takes from two to three days for a "snot" to become a "peeler." One tide will often

change a "peeler" to a "buster" and another from a "buster" to a soft crab. A few hours after shedding the crab has reached the "paper-shell" stage, and within three days the hardening process is completed. The warmer the water the more rapidly do the changes take place. It was formerly customary to break a crab's claw to ascertain whether it had begun to shed, the term "snot" no doubt having arisen from the watery substance which issued from the break. Experienced fishermen, however, find it unnecessary to resort to this test.

Crabs are sold by the fishermen principally in the "peeler" or "buster" condition, just before the shedding takes place, the proportion sold as soft crabs being much smaller. When the shell of a crab that has just shed has hardened to a "paper-shell," the fisherman is able to dispose of it at only about one-fourth the price of a soft crab. "Snots" are seldom bought by dealers, but are returned to the fisherman, who places them in his floats until they become "peelers," or are in a salable condition.

Buy-boats.—Most of the crab catch is sold on the grounds where taken, the dealers in Crisfield and Deal Island employing buy-boats for this purpose. Up to 1902 sailboats only had been used in this trade, but in the latter year gasoline launches were introduced, and both kinds of boats were employed during a portion of that season. It is very likely that the number of launches will be augmented during each succeeding season, and it is also very probable that the crabbers themselves, following the example of the lobster fishermen of New England, will add auxiliary power to their sailboats, and thereby secure the benefit of both means of propulsion. It is feared, however, that the resulting increase in catch will be greater than the natural increase of crabs.

Floats.—Every crabber has what is known as a float, a rectangular box approximately 10 or 15 feet long, 4 feet wide, and 2 feet deep, the sides and ends being constructed of laths, and the bottom of 6-inch planks. Extending around the float on the outside, midway of its height, is a shelf about 7 inches wide, to prevent the float from sinking. The laths on the sides and ends are placed about one-fourth inch apart, to prevent minnows or eels from getting at the crabs inside. These floats are used by the fishermen as a means of holding crabs that have entered upon the shedding process, but which have not yet reached the "peeler" or salable condition. The dealers also use floats, sometimes as many as 100, but usually of a larger size than those of the fishermen, and costing from $2 to $3 each. The floats are inclosed by a fence to prevent their being washed away by strong winds, and this inclosure is commonly called a "pound." The floats now in general use are made of native or "Eastern Shore" pine and ordinarily will not, unless exceptional care is taken of them, last through one season, as they soon become water-soaked and sink. One was seen

that had been used nine years, but it was made of white pine, the sides and ends being constructed of strips instead of laths as at present. By means of a rope fastened to one end, a float can be towed to any part of the pound.

Within each pound is a sloping platform upon which floats are placed at regular intervals to dry. Under ordinary conditions about one-third of the floats are in the water while the remainder are drying on this platform. If the weather is warm a float will become foul within a week and crabs put into it will die much sooner than in a clean one. The painting of floats is an innovation which promises good results in preserving them. It has been suggested that shades be placed over the floats to protect the crabs from the hot sun. This, it is thought, might materially reduce the great mortality among the crabs during midsummer, but as it has not yet been tried its usefulness is problematical. Dealers employ men to watch their floats constantly and remove the crabs from the water immediately after the shedding process, to prevent the hardening of the shell. This sorting is done three or four times a day, the intervals being employed in packing the crabs for shipment, receiving fresh supplies, and in delivering those already packed to the express office or steamboat wharf.

A source of much loss in soft crabs is the great mortality attendant upon the shedding process. If the animal has been injured in any way, either when being caught or in the subsequent handling, or if it has been weakened by being kept too long out of water, it is often unable to withdraw from the old shell and dies. There is but small demand for the crabs which die in the floats. If they are removed and cooked within two or three hours, however, they can still be eaten, and for this purpose command a small price. A few are shipped to be used as fish bait, but the majority are either thrown away or given to persons in the neighborhood who feed them to hogs or to impounded diamond-back terrapin. The mortality among shedding crabs is greatest during hot and sultry weather; thunderstorms are said to be very destructive at times, but whether this destruction is due to the sultry weather preceding or to the electrical disturbance during the storm is a disputed point. The crabs in the floats are not fed, even though they remain there for several days. It was formerly the practice to throw in pieces of stale meat or other refuse, but, although the crabs ate it, they died more quickly than if nothing was given them.

Handling and disposition of crabs.—The boxes in which crabs are shipped are made of thin pine boards and contain from two to three trays. Occasionally smaller boxes without any trays are also used. By means of the trays the lower layer of crabs may be examined without removing the upper ones, as was necessary in the boxes originally used. The present boxes, which cost from 30 to 40 cents each,

are made in several sizes, but the one most commonly used is 18 by 28 by 10 inches. From 10 to 35 dozen crabs are packed in one box, the number varying according to the box and the size of the crab, and necessarily decreasing as the season advances and the crabs grow larger.

The work of packing crabs for shipment is begun by covering the bottom of the box to a depth of 2 or 3 inches with seaweed which has been thoroughly picked over to remove all lumps. On this soft bed the crabs are placed in a nearly vertical position and so close together that they can not move out of place. Seaweed or moss is then placed over them to protect them, and over this is placed a layer of fine crushed ice. The other trays, after being packed in the same manner, are placed one above the other, and the lid is nailed on. The box is then ready for shipment. Some dealers, in order that their shipments may present a more attractive appearance upon reaching market, place a piece of cheese-cloth immediately over the crabs and the seaweed over that. By reason of the extreme care used in packing, the crabs can be kept alive from sixty to seventy hours after leaving the water, and crabs shipped from Crisfield to Canada arrive at their destination alive and in good condition. In the early days of the fishery, "peelers" were shipped from Deal Island in a large box holding 5,000, neither seaweed nor ice being used. They were sent only as far as Baltimore, however. At present most of the crabs are shipped directly to the consumer, and the packers do not hesitate to fill the smallest order. Competition among the packers is very keen, and considerable secrecy is observed regarding the destination of shipments. When a box is ready the dealer's name and address are stenciled upon it, and a tag bearing the consignee's name and address is attached; but over the latter, so as to hide it completely, is tacked a piece of cardboard bearing the letter "W" (west) or "E" (east). This is known as a "blind tag," and is not removed until after the box is in the express car, if shipped by rail, or in Baltimore, if it goes by steamer.

While the great bulk of the catch, in fact nearly all of it, is shipped in the manner described above, a small but increasing number of soft crabs are being put up in hermetically sealed tin cans for indefinite preservation. For this purpose the prime soft crabs are boiled and put up very much the same as any other animal product. From 2 to 24 entire crabs are put into each can, the former number into a can holding about one-half pint, the latter into a 1-gallon can. When put up in this manner the crabs retain much of their delicious flavor and should furnish an admirable substitute for the fresh article during the winter season.

Market prices.—The price received by the fishermen for soft crabs, or those in the process of shedding, varies from one-half to 4 cents

each, an average during the season being about $1\frac{1}{2}$ cents. In buying, the dealer often counts three small crabs as two large ones, or two small as one large one, according to the size.

Supply.—There has been no very material change in the catch of crabs throughout the region, except a slight increase due to the greater number of crabbers each year. In 1901 at Crisfield and vicinity the catch was light, while at Deal Island, Holland Island, and neighboring localities this was the most profitable season known. In 1902 the catch of crabs was small throughout the state. The fishermen attributed this to the severe winter of 1901–2. It is claimed by the residents of Deal Island that up to about 1882, when crabbing for market was begun there, it would take a fisherman a day to catch enough crabs for use as bait for line-fishing the next day.

There are no legal restrictions imposed upon crabbing in Maryland either as to the size of the crabs, or the season in which they can be taken. Dorchester is the only county in which a license is required, a fee of $2.50 being charged for the privilege of scraping. No license is necessary for scoop-netting.

Many fishermen are of the opinion that scraping for crabs over oyster grounds is of material benefit to the latter, as mud would settle on the oysters and would smother them unless removed by the scrapes; also, spat would be prevented from settling on the shells. The crabber regards scraping as a method of cultivating oyster grounds.

The early history of the crab industry of Crisfield may not be uninteresting as given in the words of Capt. John H. Landon, the first and oldest living crab shipper of this town.

When I first began crabbing in Crisfield I could catch over ten dozen crabs in a day with a scoop net. We did not know what to do with them. There were only two firms that handled them at that time, one in New York and one in Philadelphia. It was in 1873 or 1874 that the first shipments of crabs were made from Crisfield. These were consigned to the firm of John Martin, in Philadelphia, and were shipped on commission. Sometimes they would bring 60 cents a dozen, and at other times $1. The price now is kept down by the great competition among the crab buyers, who make such low rates in their contracts with firms in the cities. There was no trouble at first in selling our crabs, as the men to whom we shipped were pretty well posted, but we had considerable trouble in extending the trade, as many people thought the crabs were poisonous and had a very poor opinion of the crabbers as a set. Soft crabs were eaten in Crisfield sometime before there was any thought of shipping them to the cities. A few were at first sold to express agents and railroad employees. These men would take them to friends or sell them to game dealers in Philadelphia, which may account for the fact that Mr. Martin, to whom the first shipments were made, was familiar with their edible quality.

The boxes in which the crabs were first shipped were very heavy, which made the express charges high. That was one of the mistakes that the shippers made. We had considerable trouble in getting the crabs to market, as we did not use ice in those days, at least for the first two years. The result was that we would lose about one-half of the crabs before they reached the market. Mr. Martin was the first to suggest the use of ice. We fitted up a very nice box in which to ship them in ice, but it proved to be too expensive. It had trays, as at present, but was much heavier.

Before the use of ice we put about 5 dozen crabs in a box. After the introduction of ice we put in about 12 dozen, as we then used a larger box. Crabs were shipped in these large boxes for many years until the present style of box came into use in 1884. The latter were first used by Mr. Isaac Tawes, of the firm of Tawes & Co. In the boxes originally used the crabs were arranged in layers, but not in trays, so that if you desired to get at the bottom layer of crabs it was necessary to unpack all of those above. You could not get at them by removing the trays, as at present.

We did not ship any crabs to Baltimore for two or three years, but confined our shipments to Philadelphia and New York. One shipment was sent to Pittsburg in the interim, but no returns were received for them, as they did not appear to be salable there.

Scoop nets were probably used in taking crabs four or five years before the introduction of scrapes. L. Cooper Dize was the first man to use scrapes. The kind first used were nothing but old oyster dredges of the smallest size. A cotton bag was soon afterwards substituted for the chain bag, this change making them much lighter and better. Scrapes came into general use the next year after their introduction.

I was about the first crabber, and also the first to buy and ship. The principal reason why I stopped buying was on account of having to work on Sundays, which is the busiest day of the entire week.

The shedding of crabs was begun here almost immediately after the first shipments. The same style of floats was used as now. In our first attempt at shedding we built about five floats, each 10 feet long, 8 feet wide, and 8 inches deep. We caught a lot of small hard crabs and put them in the floats to turn to peelers. During that night a strong wind from the northwest arose and when we went to the floats in the morning we found that every one of the little crabs had shed its "fingers," and we called them "buffaloes." They were of no use whatever.

Other attempts have also been made to shed hard crabs, but they have always resulted in a failure. We built a pound and put the crabs inside. Our intention was to hold the crabs in this pound until they became peelers and then take them out and put them in floats to shed, but it necessitated so many handlings of the crabs before they became peelers that the experiment was considered a failure and discontinued. The first crab pounds were constructed by Mr. Severn Riggin and myself. They consisted of posts with boards nailed lengthwise on them, and laths nailed vertically on the boards, close enough together to keep the crabs from getting through. The first pounds were circular in shape, while those at present in use are square or nearly so, and are not so closely built, as their only purpose now is to prevent the floats being washed away by strong winds.

THE HARD-CRAB INDUSTRY.

Oxford and Cambridge are the most important hard-crab centers in the state, though the industry is prosecuted extensively in many other localities, including Crisfield, where, however, it is overshadowed by the more important soft-crab industry. At Oxford, with the exception of about one-third of the catch shipped alive during July and August, when the crabs are in their best condition, the hard-crab catch is utilized at factories, where the meat is extracted and shipped in tin buckets. This applies also to several other localities in Talbot County, which is the hard-crab county of the state. At Cambridge, with the exception of the crabs used by one firm which extracts the meat, the catch is shipped alive.

Crabbing grounds.—The larger portion of the catch is made in the Choptank, Tred Avon, Wicomico, St. Michaels, Chester, and Little Annemessex rivers, and Chesapeake Bay, on the eastern shore of the state, and in Mill Creek, a tributary of the Patuxent River, on the western shore. The crabs are taken in depths of water varying from 2 feet in the rivers to 40 feet in the open waters of Chesapeake Bay. The average depth would be about 10 feet. They usually frequent muddy bottoms, but at certain seasons of the year they are found on hard bottoms, thus differing from soft crabs, which always seek grassy bottoms.

Season.—At Crisfield the fishery for hard crabs is carried on from early in April until the latter part of November. In most other localities the season is considerably shorter. The larger portion of the catch is taken between June 1 and September 1, most of the fishermen discontinuing at the latter date to take up oyster tonging. By reason of this reduction in number the crabbers who continue during September and October succeed in making fairly good catches. They are also aided by the cooler weather, which permits of the catch being kept in good condition for shipment until the following day. During the winter quite a number of hard crabs are taken incidentally in oyster dredges. There is very little sale for these, however, except at Crisfield, where one firm is engaged in picking crab meat during the entire year. This firm depends upon New York State for most of its supply of crabs during the winter. It is thought that the winter catch could be augmented should the demand become greater.

Apparatus.—With the exception of the crabs already mentioned as being caught in oyster dredges and the few taken together with soft crabs, the entire hard-crab catch of the state is obtained with trot lines. These lines vary in length from 200 to 1,000 yards, the average being about 450 yards, and are of cotton, manila, or grass rope, the size running from one-eighth to five-eighths of an inch in diameter, but usually being about one-fourth inch. Many fishermen tar their lines, though the practice is not universal. In some localities snoods about 18 inches in length, of fine twine, are fastened to the main line at intervals of 3 to 4 feet, the bait being placed at the ends of these snoods. Other fishermen, however, use no snoods, but make a loop in the main line, through which the bait is slipped. The use of snoods is preferable where the water is rough, as the crabs are not so easily shaken off by the strain on the line when pulling the boat along and when the line is being lifted from the water in removing the crabs. Many fishermen advise their use under all circumstances, as with snoods swinging from the main line the crabs are able to see the bait from any direction. Trot lines are always anchored on the bottom of a stream. For this purpose grapnels or killicks weighing from 5 to 10 pounds are used, one being placed at each end of the line, and in many cases

one also in the center. A buoy, usually consisting of a small keg or some wooden object, is placed near each end of the line to locate it. As a rule a trot line lasts through about half of the season. The cost is from $3 to $9, varying with the length, quality, size of rope, and kind of grapnels or killicks used, the average being about $5. Some fishermen use a stake planted in the mud at each end of the line instead of grapnels or killicks. Anchors of stone or brick are also employed.

Bait.—Beef tripe and eels constitute the usual bait, though calf pelts, sting rays, hog chokers, spoilt beef, and various other substitutes are sometimes used. It is likely that the use of tripe will be discontinued in the near future, owing to the fact that the steamboats have refused to transport it on account of its offensive odor, and the railroad companies will not handle it except when it is packed in tightly sealed barrels. The bait is generally used in a salted condition, and is placed on the line at intervals of 3 or 4 feet. Fishermen bait their lines about once a week, in the meanwhile replacing any bait that may have been washed away or eaten. It is usual on Saturday or Monday to remove the old bait and put on fresh. After a line has been rebaited it is placed in a coil and covered with salt to preserve the bait until it is used.

Manner of fishing.—With few exceptions only one man goes in a boat. The lines are set about one-fourth to the tide, or diagonally across a stream. In fishing, the line is drawn across the bow of the boat; a short-handled scoop net is used to transfer the crab to the boat. The lines are overhauled from 10 to 20 times in the course of a day. During calm weather it is customary to overhaul them from both ends—that is, going and coming—while with a breeze it is considered more advantageous to work from the windward, that the boat may drift with the wind. This facilitates the handling of the line and permits of more crabs being saved than would be the case in working from the leeward. With a long line the advantage of overhauling from both ends is more apparent, as the crabs have less chance to devour the bait. In some localities crabbers aim to reach the fishing grounds shortly after midnight, while at others they arrive as late as 3 or 4 o'clock in the morning. The object in going early is to get a good lay. If it is a moonlight night the lines are set as soon as a lay is reached, but if it is dark the crabbers await daylight, in the meanwhile taking a nap. Crabs very seldom bite before daylight, but if they do not begin soon after, the fishermen consider it as well to return home. Very few crabs are taken between 10 o'clock in the morning and 3 o'clock in the afternoon, both on account of the heat and the difficulty in getting the catch ashore in good condition. Hard crabbers are dependent upon neither wind nor tide, but should the water be rough the crabs are liable to be shaken off before they can be caught.

Boats.—The boat used by the crabber must necessarily be light, for when hauling in the line hand over hand the boat is pulled along at the same time. The boats vary in length from 12 to 24 feet. At Cambridge and Crisfield a lighter and cheaper boat is used, while at Oxford and other localities there is a growing tendency to build boats suitable for both crabbing and oyster-tonging. These average 25 feet in length, 2 feet deep, and from 5 to 6 feet wide, and have a dead-rise bottom. Boats of this character cost from $40 to $50, and are designated skiffs and batteaus.

Doublers.—Very often a male and female crab when mating are taken together on a trot line, this usually occurring when the female is entering the shedding stage. The pair are called "doublers," or "channeler and his wife." In most localities where hard crabs are taken there are one or more firms handling soft crabs—that is, those taken on trot lines as "doublers." At some places there is no sale for the female thus taken, and she is returned to the water, while in other localities she is sold along with the hard crabs at the same price. The proportion of "doublers" taken varies in different localities from 1 in 100 crabs to 1 in 10, and they are generally taken on grassy bottoms. A "channeler," or any large male hard crab, is called a "Jimmy" or "Jim crab."

Size of crabs.—The size of a market crab varies with the season and also with the locality. Early in the season 500 will fill a sugar barrel, while later from 200 to 300 is sufficient. The average weight of a single crab is about one-third of a pound. Two were taken near Crisfield early in 1902 weighing 1 pound each. The smallest crabs that are ever taken in that locality are about the size of a man's finger-nail. The supposition that crabs spawn in the ocean near Cape Charles would account for the fact that no smaller ones are taken.

Floats.—Floats are not used among hard crabbers except in the case of dealers and those shipping their own catch. In localities where crab meat is picked and utilized, floats are used only by dealers handling peelers or the females taken with the "channelers" while mating. The floats are similar to those used in the soft-crab trade, though wire is sometimes substituted for laths in their construction. It is claimed that the wire does not catch filth from the water so quickly as the lath floats, and it is more easily brushed off. At Mount Vernon every crabber has two floats, so that he may place a day's catch in one and allow it to remain until time for shipment, and reserve the other float for the next day's catch. It is claimed that a day's captivity lessens the likelihood of the crabs attacking and maiming each other.

Disposition of catch and price.—The crabs are disposed of in different ways. Probably the largest proportion is sold to factories for the extraction of the meat. The remainder is either shipped alive by the crabbers or sold to dealers, who also ship it in a live state. In some

localities where the catch is small the crabs are sold locally either alive or deviled. The price received per barrel by the crabbers throughout the crab region varied in 1901 from 50 cents to $2, the latter being the price received by those marketing their own catch. In some instances only 10 cents a barrel was realized, but few were shipped at this price. In 1902 the price was nearly double that in 1901.

Manner of shipment.—Live hard crabs are shipped in either barrels or boxes. At Cambridge a box 22 inches long, 10 inches wide, and 12 inches deep is used. There are spaces between the boards on the top of the box for the admission of air. At practically all of the other crabbing localities sugar and slatted barrels serve the purpose, or occasionally banana baskets. With the exception of about 20 pounds of ice placed over the crabs, nothing is put in the shipping packages with them, the only other provision to keep them alive being small holes in the top and sides of the barrel. This is not necessary in the case of slatted barrels or banana baskets.

Preparation of crab meat.—At Oxford, St. Michaels, Tilghman, and several neighboring localities almost the entire catch is utilized in cooking the meat which is shipped in tin buckets having perforated bottoms and holding from 5 to 6 pounds. Oxford is probably the pioneer locality in this branch of the industry, which has been carried on there for more than twenty years. About 1880 a Mr. Thomas began canning crab meat. He is said to have succeeded perfectly in preserving the meat, but as this was a new industry the demand for the product was limited, and on account of the expense of operating and advertising the factory was soon closed. About three years later the method at present in use—namely, steaming the crabs, extracting the meat, and shipping in unsealed packages—was begun by Mr. J. G. Schultz. This business has extended until now there are 7 firms at Oxford alone, and 20 in the entire state.

The crab meat is prepared as follows: Immediately upon arrival at the factory the crabs are dumped into a large box, through which steam is forced from the bottom. They are steamed from twenty to forty minutes, the time varying at different factories, and according to the number cooked. After this the crabs are distributed among the pickers, some of whom, with long experience, become very expert in extracting the meat. The pickers in most cases are white women and children, though at some factories all are colored. The price received by the pickers is usually from 4 to 5 cents a quart of meat (about 2 pounds). The meat is divided into three classes—flakes, ordinary, and fat meat, the flakes being considered much superior to the other because they are whiter and firmer. They are taken mostly from the "hip" of the crab. The sale of fat meat is confined to one or two firms, who use it principally in preparing deviled crabs. After the meat has been extracted ice water is thrown over it and about 3 ounces of salt added to each 20 pounds of meat. Some dealers, how-

ever, think a briny solution thrown over the meat is more satisfactory than the dry salt. The meat is packed in buckets after it is salted and is placed in a large ice box and covered with ice, where it remains until shipped. There are commonly three sizes of buckets, holding, respectively, 5½ pounds, 2½ pounds, and 1 pound each. The amount of meat in a bucket varies somewhat at times, according to the condition of the crabs and the pressure applied in extracting the moisture. The thinner the crab the more moisture it contains. During the season of 1901 the meat from a barrel of hard crabs filled, on an average, 3¾ buckets of the largest size. Two firms, instead of steaming, boil their crabs about 30 minutes before removing the meat. It is claimed by some that more water remains in the meat after boiling than after steaming.

The business of putting up crab meat in sealed cans is carried on by only two firms in the state—one at Crisfield and the other at Bivalve. The former has already been referred to in connection with the soft-crab industry, in which it is engaged. The problem of preserving the meat indefinitely has been very difficult to solve, and but few firms have been successful; one of these, located in Virginia, was about the first in the field.

Use of shells.—After the meat has been extracted the crab shells are cleaned and a certain number are sent with every shipment of meat, to be used principally in making deviled crabs. In the case of small orders, say from 5 to 7 gallons of meat, buckets are placed in the bottom of a barrel and covered with ice, and the barrel is then filled with shells. When a larger shipment is made the meat is placed in one barrel and the shells in another. On an average from 80 to 100 shells are sent with each gallon of meat. Boys are usually employed in cleaning the shells, and are paid about 5 cents a hundred. When shipped separately the shells are sent in sugar and flour barrels, the former holding 1,800 shells and the latter 1,200.

A factory at Oxford has been engaged during the last two seasons in grinding crab shells and disposing of the resultant product to fertilizer manufacturers for use as an ingredient. When the shells are brought to the factory they are placed in a revolving cylinder, through which a draft of hot air is passed to dry them, and then are spread over the floor of the factory to allow any remaining moisture to evaporate. After they are thoroughly dried they are placed in a grinding machine operated by steam, and ground into a fine meal, in which condition the product is ready for shipment. Its value as an ingredient for fertilizer is due to the 9 per cent of ammonia which it contains. The use of the revolving cylinder is said to lessen the escape of the ammonia. The shells are secured from crab houses at a nominal cost. Up to the present time the factory has been able to get about one ton of shells per day, which is just enough to justify its operation.

The following table shows the extent of the crab fishery of Maryland in 1901. The total number of men engaged was 5,388. Sixty-

nine vessels, valued at $24,000, were employed, 55 of these being engaged in taking crabs and 14 in transporting them. The total number of boats used was 4,082, valued at $125,847. Including vessels, boats, apparatus, shore property, and cash capital, the investment in the fishery was $321,974. The catch was 12,910,746 soft crabs, valued at $202,563, and 29,474,379 hard crabs, valued at $85,884. The largest catches of soft crabs were made with scrapes, the value of the catch by this apparatus being nearly double that taken in scoop nets, which is the next important apparatus. Practically the entire hard-crab catch was obtained on trot lines, 1,138 of these lines, valued at $4,474, being operated. A few hard crabs also were taken in scrapes during the soft-crab season, and in dredges during the oyster season; $10,464 worth of soft crabs was taken incidentally along with hard crabs on trot lines as "doublers."

The following is a summary of the crab fishery of Maryland in 1901:

Table showing, by counties, the extent of the crab fishery of Maryland in 1901.

Items.	Anne Arundel.		Baltimore.		Calvert.		Charles.		Dorchester.	
	No.	Value.	No.	Val.	No.	Val.	No.	Val.	No.	Value.
Persons engaged:										
Soft crabbers	157		32		100				435	
Hard crabbers	96		2		36		18		242	
Shoresmen	123		16		3				65	
On vessels transporting crabs									1	
Total *a*	376		50		139		18		743	
Vessels soft crabbing									35	$12,625
Tonnage									224	
Outfit										800
Vessels transporting crabs									1	100
Tonnage									8	
Outfit										10
Boats, soft crabbing	134	$1,559	16	$160	70	$560			296	10,485
Boats, hard crabbing	96	2,089	1	14	36	330	18	$144	214	3,105
Total *a*	230	3,648	17	174	106	890	18	144	510	13,590
Apparatus used in soft crabbing:										
Scrapes									337	1,141
Scoop nets	157	83			100	20			298	104
Seines	35	105	16	432						
Apparatus used in hard crabbing:										
Trot lines	40	470	2	1	36	131	18	45	227	810
Shore and accessory property		4,905		1,042		428				445
Cash capital		1,400				300				3,090
Total investment		10,611		1,649		1,769		189		19,180
Soft-crab catch by—										
Scrapes									698,500	10,750
Scoop nets	373,560	10,704			180,000	2,250			449,100	6,835
Seines	139,440	3,704	18,000	1,200						
Trot lines *b*	800	27	861	58	798	1			109,398	5,940
Total	513,800	14,435	18,861	1,258	180,798	2,251			1,556,998	23,525
Hard-crab catch by trot lines	3,487,695	8,794	1,440	12	543,999	884	630,000	2,100	4,992,999	18,337
Total catch, soft and hard crabs	4,001,495	23,229	50,304	1,270	724,797	3,135	630,000	2,100	6,549,997	41,862

a Exclusive of duplication.
b These lines are used primarily for hard crabs, the soft or shedding crabs being taken with the hard crabs as "doublers."

Table showing by counties the extent of the crab fishery of Maryland in 1901—Cont'd.

Items.	Kent.		Queen Anne.		St. Mary.		Somerset.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Persons engaged:								
Soft crabbers	26		39		20		2,164	
Hard crabbers	115		93		60		89	
Shoresmen							250	
On vessels transporting crabs							20	
Total *a*	135		129		80		2,462	
Vessels soft crabbing							20	$7,375
Tonnage							113	
Outfit								500
Vessels transporting crabs							12	3,500
Tonnage							80	
Outfit								300
Boats, soft crabbing	13	$135	25	$198	15	$140	2,340	92,555
Boats, hard crabbing	105	1,045	93	558	60	590	90	1,015
Total *a*	112	1,120	115	735	75	730	2,430	93,600
Apparatus used in soft crabbing:								
Scrapes							2,492	9,097
Scoop nets	23	4	35	10	50	13	1,443	562
Seines	12	38	17	89				
Apparatus used in hard crabbing:								
Trot lines	105	303	93	197	60	147	90	291
Shore and accessory property		115		80		30		27,414
Cash capital								81,150
Total investment		1,580		1,111		920		212,117
Soft crab catch by—								
Scrapes							6,876,486	103,259
Scoop nets	8,700	175	31,200	685	15,075	419	3,156,210	49,378
Seines	20,120	430	66,498	1,425				
Trot lines *b*	24,000	700	20,400	360			72,000	1,300
Total	52,820	1,305	118,098	2,470	15,075	419	10,104,696	153,937
Hard crab catch by trot lines	1,174,000	2,535	2,073,498	4,908	592,500	1,975	2,306,700	12,496
Total catch, soft and hard crabs	1,226,820	3,840	2,191,596	7,378	607,575	2,394	12,411,396	166,433

a Exclusive of duplication.
b These lines are used primarily for hard crabs, the soft or shedding crabs being taken with the hard crabs as "doublers."

Table showing, by counties, the extent of the crab fishery of Maryland in 1901—Cont'd.

Items.	Talbot.		Wicomico.		Worcester.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Persons engaged:								
Soft crabbers	34						3,007	
Hard crabbers	403		72		2		1,228	
Shoresmen	615		158				1,230	
On vessels transporting crabs			2				23	
Total [a]	1,022		232		2		5,388	
Vessels soft crabbing							55	$20,000
Tonnage							337	
Outfit								1,300
Vessels transporting crabs			1	$400			14	4,000
Tonnage			5				93	
Outfit				10				320
Boats, soft crabbing	17	$760					2,926	106,552
Boats, hard crabbing	393	10,681	72	502	2	$20	1,180	20,126
Total [a]	395	10,694	72	502	2	20	4,082	125,847
Apparatus used in soft crabbing:								
Scrapes	2	9					2,831	10,247
Scoop nets	30	15					2,136	811
Seines	15	37					95	701
Apparatus used in hard crabbing:								
Trot lines	393	1,929	72	143	2	4	1,138	4,474
Shore and accessory property		29,250		4,320				68,029
Cash capital		15,925		10,000				111,865
Total investment		57,859		14,965		24		321,974
Soft crab catch by:								
Scrapes	1,800	35					7,576,786	114,044
Scoop nets	16,299	340					4,230,144	70,786
Seines	24,498	510					298,556	7,269
Trot lines [b]	277,000	2,078					805,260	10,464
Total	319,597	2,963					12,910,746	202,563
Hard crab catch by trot lines	11,314,550	28,753	2,352,000	5,040	4,998	50	29,474,379 [c]	85,884
Total catch, soft and hard crabs	11,634,147	31,716	2,352,000	5,040	4,998	50	42,385,125	288,447

[a] Exclusive of duplication.
[b] These lines are used primarily for hard crabs, the soft or shedding crabs being taken with the hard crabs as "doublers."
[c] Includes 95,000 hard crabs, valued at $235, taken in crab scrapes, and 67,000 hard crabs, valued at $500, taken while dredging for oysters.

THE COMMERCIAL FISHERIES OF THE HAWAIIAN ISLANDS IN 1903

By JOHN N. COBB
Agent of the Bureau of Fisheries

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INTRODUCTION.

The first investigation of the commercial fisheries of the Hawaiian Islands ever undertaken was made by the writer in 1901, and the results were published in the early part of 1902.[a] In 1904, in order to supply data of comparative value, another investigation was conducted, the inquiry relating to the calendar year 1903. The canvass was greatly facilitated by the courtesy and assistance of the officials and various citizens of the islands. The statistical and other information gathered appears in the following pages.

The most diverse statements have appeared in both official and private reports as to the islands properly to be included in the Hawaiian group. The following list, which was published in the Hawaiian Almanac and Annual for 1904, was compiled for the purpose of clearing up the matter, and contains the date of annexation of the more recent additions to the group: Hawaii, Maui, Oahu, Kauai, Molokai, Lanai, Niihau, Kahoolawe, Lehua, Molokini, Nihoa or Bird Island (1822), Laysan (1857), Lysiansky (1857), Palmyra (1862), Ocean (1886), Necker (1894), French Frigate Shoal (1895), Gardener, Mara or Moro Reef, Pearl and Hermes Reef, Gambia Bank, and Johnston or Cornwallis Island. The first eight have a permanent population; the others are visited during certain seasons or only occasionally, by guano workers, roving fishermen, and hunters.

FISHERY LAWS.

Private ownership of the fishes found in the open sea and bays in the immediate vicinity of the shore was one of the peculiar features of the Hawaiian fisheries before the annexation of the islands by the United States. Such "fishery rights" (which are described in detail

[a] Commercial Fisheries of the Hawaiian Islands. By John N. Cobb. Report U. S. Fish Commission, 1901, pp. 353-499. 1902. Reprinted in Bulletin of the U. S. Fish Commission, 1903, Pt. II, pp. 715-765. 1905.

in the previous report) were, however, inconsistent with the laws of this country, and the act creating the Territory of Hawaii, which went into effect June 14, 1900, contained specific legislation regarding them. It was provided that all for which claim had not been made up to June 14, 1902, should be abolished and the privileges they carried should become common property; those which might be proved to be of the nature of vested rights should eventually be condemned and opened to common use, but the owners would be compensated therefor.

When the time for action came, on June 14, 1902, the territorial government set up the defense that a "fishery right" was not a vested right, but merely a license, and hence the Territory was not required to compensate the owners of such alleged rights for their extinguishment. Several of the parties entered suit in the lower territorial courts and were defeated. Two of the cases—those of the Bishop estate for the fishery of Waialae-iki and Samuel M. Damon for the fishery of Moanalua—were appealed to the supreme court of the Territory, with the same result as in the lower courts. Mr. Damon thereupon carried his case on appeal to the United States Supreme Court, where it was argued in March, 1904, and on April 25 of the same year the court handed down a decision upholding the contention of Mr. Damon, the plaintiff, that a "fishery right" was a vested right.

The present status of the claims is thus set forth in a paragraph of a letter from Mr. Lorrin Andrews, attorney-general of the Territory, dated October 8, 1904:

> The decision of the United States Supreme Court has practically precluded us from setting up the defense that the parties already suing had not vested rights in the property. We are therefore requiring each person suing to prove his title, as alleged in the complaint, upon which we consent that a judgment be entered against the Territory, and we will immediately bring condemnation proceedings against such established owners of fisheries, so as to obtain the title for the Territory. This will probably be done some time before the spring of next year, as there are a large number of cases, and of necessity we must proceed slowly.

The abolition of private fishery rights wiped out the greater part of the fishery laws previously in force on the islands, and at present the following seem to be all that are in effect:

> In 1850, under the heading of "Malicious injuries and mischiefs," the "destroying, cutting, injuring, or impairing the usefulness or value of any fish net," etc., and the "putting of auhuhu or other substance deleterious to fish into any lake, pond, stream, or reservoir for the purpose of destroying the fish," were made misdemeanors.

> "No person residing without the Kingdom shall take any fish within the harbors, streams, reefs, or other waters of the same for the purpose of carrying them for sale, or otherwise, to any place without the Kingdom, under penalty of a fine not exceeding two hundred dollars, in the discretion of the court." (Civil Code of 1859, Chap. VII, Art. V, sec. 386.)

> "SECTION 1. No person shall use giant powder or any other explosive substance in taking fish within or upon any harbors, streams, reefs, or waters within the jurisdiction of this Kingdom. The possession by fisherman, fish venders, or persons in

the habit of fishing, of fish killed by giant powder or other explosive substance shall be prima facie evidence that the person in whose possession such fish were found used giant powder or some other explosive substance in taking such fish, contrary to the provisions of this act.

"SEC. 2. Whoever violates the provisions of this act shall be punished by a fine not exceeding one hundred dollars and not less than twenty-five dollars, or by imprisonment at hard labor not exceeding six months, or both, in the discretion of the court.

"SEC. 3. The several district justices and police courts shall have concurrent jurisdiction in all cases under this act."

(Law was passed first in 1872 and has been amended frequently since.)

"SECTION 1. It shall not be lawful for any person to take, catch, or destroy the young of the fish known as the mullet and the awa under four inches in length in any of the bays, harbors, waters, or streams of this Kingdom: *Provided, however*, That nothing in this act shall prevent the taking of the fish herein above prohibited for the purpose of stocking ponds.

"SEC. 2. It shall not be lawful for any person to sell or offer for sale, or have in his possession, except alive, any of the young fish mentioned in section one of this act.

"SEC. 3. Any person violating the provisions of this act shall, upon conviction before any police or district magistrate, be punished by a fine of not less than twenty dollars nor more than two hundred dollars, or by imprisonment at hard labor for not less than ten nor more than ninety days, or by both such fine and imprisonment, in the discretion of the court: *Provided nevertheless*, That no such fine shall be imposed upon any person who, fishing for other fish, accidentally takes or catches no more than forty of the young fish mentioned in section one of this act.

"SEC. 4. This act shall take effect from and after the date of its approval."

(Law approved September 6, 1888.)

While in general the effect of the extinguishment of the "fishery rights" will be extremely beneficial to the fisheries, in some respects it will not be wholly advantageous unless the territorial government takes prompt action. A few of the more public-spirited owners of "fishery rights" made every possible effort to conserve and increase the supply of fish, and through the medium of the provision in the law allowing such owners "in lieu of setting apart some peculiar fish to their exclusive use * * * to prohibit during certain indicated months of the year all fishing of every description upon their fisheries," they placed tabooes on certain fish—notably the ama-ama—during their spawning seasons, and thus gave a measure of protection which is entirely lacking at present. The only species now protected are the young of the ama-ama and the awa, it being unlawful to take these fishes under 4 inches in length. So far as the ama-ama is concerned this law is disregarded in all but a few places. Thousands of young mullet, from 1 to 2 inches in length, and known as "pua," are taken by the fishermen of Molokai and Maui in fine-meshed nets and sold. Large quantities are taken in the fisheries of the other islands, also, particularly Oahu, and sold to the workmen on the sugar plantations. As the ama-ama is one of the most valuable elements in the fisheries, every effort should be made to conserve it, and if the law were rigidly

enforced its beneficial effects would be soon apparent. Under the present conditions the fishery, instead of increasing as a result of the greater efforts put forth in recent years, has slightly decreased since 1900.

The fine-meshed nets in such general use throughout the islands, and more especially in Pearl Harbor, destroy the young of other species, notably the akule and ulua, both of which are valuable food fishes. Thousands of these, from 2 inches in length up, are caught and sold, and, as the law does not protect them, nothing can be done to stop the slaughter. The data collected for the year 1903 show a decrease in the catch of ulua of 177,080 pounds since 1900. In the same period of time the catch of akule quite materially increased, but this was owing to the introduction by the Japanese of a method of catching them with hook and line.

Heretofore all efforts to prohibit the use of these fine-meshed nets have been blocked by the native members of the legislature, who claimed that it would deprive their native constituents of the opportunity to gratify their desire to eat little fishes raw. Of these the favorite species is the nehu, which never grows large. It, however, is an important food of larger and more valuable fishes, and for this if for no other reason should be protected. The fine-meshed nets are used almost entirely by the Japanese, who throw away probably one-fourth of the catch in some localities, notably in Pearl Harbor, in order to keep up the present high prices of fish.

THE COMMERCIAL SPECIES.

At the time of the 1901 investigation considerable difficulty was experienced in classifying the commercial species, owing to the lack of scientific data on Hawaiian fishery products, nearly all of which bore native names, and but few of which were to be found in other United States waters. To make confusion worse confounded, the fishermen, in many instances, call the same species by different names at various stages in its life, and also when there is a slight variation in its external appearance. The study of the large collections made under the auspices of the Bureau of Fisheries in 1901 and 1902 and by private collectors has greatly aided in identifying the various species and in straightening out the tangle of native common names. Even yet a few of the latter are unidentified, but these are species unimportant commercially. In order to prevent confusion and misapprehension among the fishermen and others, a list of the commercial species has been prepared, showing the names used in the statistical tables; and where two or more species have been included under one name, as in the case of the young of the species when it bears a different name from the adult, the other names are shown in the list immediately

below and are slightly indented. The common English name and the scientific name are also shown where possible, but as few of the Hawaiian fishes and other aquatic animals are found in the United States, or where there are English-speaking fishermen, only a few of them have received English names. The English names in the list are, in most instances, generic rather than specific, or such as are applied to all or several of the species of a genus.

An interesting feature of this list is the determination of the average weight of nearly all the species sold in the markets. As all fish are sold by the piece, except in the case of large species, which are cut up before being sold, it proved quite a serious undertaking to secure these data. As many of each species as possible were weighed, and only when this was impossible were estimates, furnished by responsible parties, used. The latter was the case more especially with the rarer species, which only occasionally find their way into the markets, and with those which were not in season at the time of the inquiry. When estimates are used they are designated thus (e). The list follows:

List of the species taken in the commercial fisheries of the Hawaiian Islands.

Native name.	Common English name.	Average weight.	Scientific name.
Fishes.			
A'alaihi		10 to pound	Thalassoma duperrey.
A'awa	Wrasse-fish	11 ounces	Lepidaplois albotæniatus; L. strophodes.
Áhaáha	Needle-fish	5½ ounces	Athlennes hians; Tylosurus giganteus.
Ahi	Albacore	30 pounds	Germo germo.
Ahia	do		
Ahólehóle		2 ounces	Kuhlia malo.
Ákilólo			Gomphosus, Thalassoma, etc.
Aku	Ocean bonito	5 pounds	Gymnosarda pelamis.
Akule	Mackerel scad	10 ounces	Trachurops crumenophthalma.
Hahalalu (young)	do	5 to pound	Do.
Alaíhi	Squirrel-fish		Holocentrus (any species).
Aléiléi (a small fish found in little tide pools.)			Dascyllus; Pomacentrus.
Ama-ama	Mullet	5 ounces	Mugil cephalus.
Anáe (adult)	do	2¼ pounds	Mugil.
Anaehole	do		Do.
Puai'i (very young)	do		Do.
Ápi			Chirurgus guttatus. Zebrasoma hypselopterum.
A'u	Sword-fish	1 weighed 160 pounds.	Xiphias gladius.
Auau	Needle-fish	4 pounds	Tylosurus giganteus.
Awa kalamoku (large adult).	Milk-fish	15 pounds (e)	Chanos chanos.
Awa (commercial size)	do	½ pound	Do.
Awa-awa (medium sized)	do	3 pounds	Do.
Puawa (young)	do		Do.
Awela		10 ounces	Thalassoma purpureum.
Hou (large)		4 pounds	Do.
Palaea (very small)			Do.
Aweoweo (adult)	Catalufa	9 ounces	Priacanthus cruentatus.
Alalaua (young)	do		Do.
Carp *a*			Cyprinus carpio.
China-fish *a*		½ pound (e)	Ophiocephalus.
Gold-fish *a*		10 to pound	Carassius auratus.
Hapú'u pú'u	Grouper	15 pounds	Epinephelus quernus.
Haúliúli	Snake mackerel		Lemnisoma serpens.
Hihimánu	Spotted sting-ray	25 pounds (e)	Stoasodon narinari.
Hilu (generic name)	Wrasse-fish	3 pounds	Anampses cuvieri.
Hilu lauwili	do		Julis lepomis, Thalassoma sp., etc.

a Introduced species.

List of the species taken in the commercial fisheries of the Hawaiian Islands—Continued.

Native name.	Common English name.	Average weight.	Scientific name.
Fishes—Continued.			
Hinaléa (generic name)	Wrasse-fish	4 ounces	Thalassoma ballieui.
Hinaléa Lauwili	do		Thalassoma duperrey.
Hinaléa niau	do		
Hinaléa pála-pála-úli	do		
Hinaléa Luahine	do		Thalassoma ballieui.
Hinaléa Lolo	do		Julis pulcherrima.
Hou (Hawaii)		1 weighed 4 pounds	Thalassoma purpureum.
Húmuhúmu nukunuku apua'a.	Trigger-fish	13 ounces	Balistapus rectangulus; Hemiramphus depaúperátus.
Iheihe	Half-beak	4 to pound (e)	Euleptoramphus longirostris; Hemiramphus depauperatus.
Kahála	Amber-fish	30 pounds	Seriola purpurascens.
Káku	Barracuda	2 pounds	Sphyræna.
Kála	Surgeon-fish	1 pound (e)	Acanthurus unicornis.
Pakálakála (young)	do		Do.
Kálekále		12 ounces	
Káwakáwa	Bonito	3 pounds	Gymnosarda alletterata.
Kawelea	Lizard-fish	1½ pounds	Trachinocephalus myops.
Keke	Puffer	1 pound (e)	Tetraodon hispidus.
Kihikihi	Moorish idol and surgeon-fish.		Zanclus canescens; Zebrasoma veliferum.
Kikakápu	Butterfly-fish		Cheilodactylus vittatus; Chætodon sphenospilus, Chætodon lunula, ornatissimus, unimaculatus.
Koá'e		10 to pound (e)	Ctenochætus strigosus?
Kóle	Snapper	1 weighed 4 pounds	Bowersia ulaula.
Kumu	Goat-fish	1½ pounds	Pseudupeneus porphyreus.
Ahuluhulu	do	10 to pound (e)	Do.
Kupipi			Abudefduf sordidus.
Kupóupóu	Wrasse-fish	12 to pound (e)	Cheilio inermis.
Lae	Mackerel	1 pound	Scomberoides tolooparah.
Laenihi		10 ounces	Hemipteronotus; Iniistius.
Laipála	Surgeon-fish	6 to pound (e)	Zebrasoma flavescens.
Lao	Wrasse-fish		Halichœres lao.
Lauhau	Butterfly-fish	12 to pound (e)	Chætodon quadrimaculatus.
Lólohau	Flying gurnard	6 to pound (e)	Cephalacanthus orientalis.
Loulo			Alutera monoceros.
Loulu	Moorish idol		Zanclus canescens.
Máhimáhi	Dolphin	25 pounds	Coryphæna hippurus.
Maii'i	Surgeon-fish	6 to pound (e)	Hepatus elongatus.
Maikoiko	do	9 ounces	Hepatus atramentatus.
Maka'a	Cavallas	10 to pound (e)	Carangus politus; Malacanthus parvipinnis.
Malámaláma		6 to pound (e)	Coris rusea.
Malolo	Flying-fish	2 to pound (e)	Cypsilurus simus.
Puhiki'i	do	12 to pound (e)	Parexocœtus brachypterus.
Mamáma	Demoiselle		Abudefduf abdominalis.
Mamámo	Rudder-fish	10 to pound (e)	Kyphosus fuscus.
Mamámu	Porgy		Monotaxis grandoculis.
Manéonéo			Zebrasoma hypselopurum.
Manini	Surgeon-fish	6 ounces	Hepatus sandwichensis.
Mano (general name for sharks).	Shark		Carcharias, any species.
Mano-kihikihi	Hammer-headed shark.	2½ pounds	Sphyrna zygæna.
Mano-nihúi	Shark	40 pounds (e)	
Mano-mólemóle	do		
Manononi (on Hawaii)		1 weighed 2 pounds	
Maumau		6 to pound (e)	
Mikiáwa	Herring	3 to pound (e)	Etrumeus micropus.
Móa	Trunk-fish		Ostracion sebæ.
Moáno	Goat-fish	6 ounces	Pseudupeneus multifasciatus.
Moi	Threadfin	1½ pounds (e)	Polydactylus sexfilis.
Moilii (young)	do		Do.
Mu	Porgy	1 pound	Monotaxis grandoculis.
Munu	Goat-fish		Pseudupeneus bifasciatus.
Naenae	Surgeon-fish		Hepatus olivaceus.
Nehu	Anchovy	40 to pound (e)	Anchovia purpurea.
Nenue (sometimes spelled "Enenue").	Rudder-fish	2 pounds (e)	Kyphosus fuscus.
Nóhu	Mail-cheeked fishes.	3 pounds	Scorpænopsis gibbosa, etc.
Nóhupináo	Flying-fish	1 pound (e)	
Nukumomi		4 pounds	
Nunu	Trumpet-fish	3 to pound (e)	Aulostomus valentini.

List of the species taken in the commercial fisheries of the Hawaiian Islands—Continued.

Native name.	Common English name.	Average weight.	Scientific name.
Fishes—Continued.			
Ohua	Wrasse-fish		Cantherines sandwichiensis; Osbeckia scripta.
O'ili			Stephanolepis spilosoma.
O'ililepa	File-fish		Osbeckia scripta; Cantherines sandwichensis.
Oio	Bonefish	9 ounces	Albula vulpes.
Amoomoo	do		Do.
Okúhekúhe (fresh water)	Goby		Eleotris fusca?
Olale		2 to pound (e)	Thalassoma purpureum.
Omakaha	Herring	3 ounces	Scorpænopsis gibbosa; Etrumeus macropus.
Omilu	Cavalla	6 pounds (e)	Carangus melampygus.
Ono	Bonito	60 pounds	Acanthocybium solandri.
Oópu	Goby	12 to pound (e)	Eleotris sandwicensis, etc.
Hinana (young)	do		
Oópuhúe[a]	Puffer	1 pound (e)	Tetraodon hispidus; Chilomycterus affinis.
Keke	do		
Maki-maki (deadly death).	do		Tetraodon hispidus.
Oópukái		12 to pound (e)	Cirrhitus marmoratus.
Opakapaka	Snapper	5 pounds (e)	Bowersia violescens; Apsilus microdon.
Opélu	Mackerel scad	6 ounces	Decapterus sanctæ-helenæ.
Opule	Wrasse-fish	½ pound	Anampses cuvier; Thalassoma purpureum.
Páka	Eel	10 pounds (e)	
Paki'i	Flounder	8 to pound (e)	Platophrys mancus.
Pakuikui			Hepatus achilles.
Paláni		8 to pound (e)	
Palúkalúka	Parrot-fish		Callyodon paluca.
Panuhúnuhú	do	1 weighed 4 pounds	Callyodon gilberti.
Paó'okauila	Blenny		Salarias brevis.
Páopáo	Cavalla	12 to pound (e)	Caranx speciosus.
Pauú	Squirrel-fish	1 weighed 3 pounds	Myripristis chryseres.
Pihá		24 to pound (e)	
Pilikó'a		8 to pound (e)	Paracirrhites forsteri; P. arcatus; P. cinctus.
Póopá'a		7 ounces	Dascyllus albisella; Paracirrhites cinctus.
Pooú	Wrasse-fish	1¼ pounds	Cheilinus hexagonatus.
Poupou		12 to pound (e)	
Púakahála	Amber-fish		Seriola purpurascens.
Puálu	Surgeon-fish	2 pounds	Hepatus dussumieri, etc.
Puhi (generic name)	Moray	3 pounds	Gymnothorax, any species.
Puhi kápa			Echidna nebulosa.
Puhi kauila	Moray		Muræna kailuæ.
Puhi kumúóne	do		
Puhi léiháia	do		
Puhi laúmilı	do		Echidna undulatus.
Puhi móeóne	do		
Puhi páka	do		
Puhi úha	Conger eel		Leptocephalus marginatus.
Puhi wéla	Moray		Echidna pictus?
Puuili	Half-beak		
Úhu	Wrasse-fish	2¾ pounds	Julis lepomis; Callyodon lineatus.
Úhuúla	Parrot-fish		Scarus ahula.
Uiúi	Flounder		Platophrys pantherinus.
Ukikiki	Snapper	3 ounces	Platyinius microdon.
Uku	do	5 pounds (e)	Aprion virescens.
Uláe	Lizard-fish	6 to pound (e)	Synodus varius; Saurida gracilis.
Ulaula	Snapper	2½ pounds	Etelis marshi, Bowersia ulaula.
Ulua	Cavalla	23 pounds	Carangus latus.
Papíopío (young)	do	10 to pound (e)	Do.
Pa' upa'u	do	7 ounces	Do.
Ulua kihikihi	Thread-fish		Alectis ciliaris.
Úmaúmalei		6 to pound (e)	
Uouóa	Mullet	½ pound	Chænomugil chaptalii.
Upapálu	Cardinal-fish	30 to pound (e)	Amia menesemas.
U'u	Squirrel-fish	4 ounces	Myripristis murdjan.
Uwau		2 to pound (e)	
Uwiwi			Stephanolepis spilosomus.
Wálu	Surgeon-fish		Hepatus xanthopterus.
Weke (generic name)	Surmullet	12 ounces	Mulloides.
Weke puéo	Goat-fish		Upeneus arge.
Weke pahúla (tail barred).	do		Do.

[a] Reputed to be very poisonous.

List of the species taken in the commercial fisheries of the Hawaiian Islands—Continued.

Native name.	Common English name.	Average weight.	Scientific name.
Fishes—Continued.			
Welea	Lizard-fish		Trachinocephalus myops.
Wolu		20 pounds (e)	
Crustacea.			
Aloalo	Prawn?	4 ounces	
Opae	Shrimp	150 to pound (e)	
Papai	Crab	2¼ ounces	
Aama	do		
Alamihi	do		
Ula	Crawfish	1½ pounds	
Ulaapapa	do	1½ pounds	
Mollusca.			
Conch	Conch		Purpura aperta.
Haukeuke			
Hee	Octopus	3 pounds	
Hee puloa	do		
Puloa	do		
Ina (with short spines)	Sea-urchin	10 to pound (e)	
Leho	Cowrie		Cypræ carneola, etc.
Muhee	Squid?	7½ pounds	
Olepe	Clam	8 to pound, including shell.	Tellina rugosa.
Opihi	Limpet	60 to pound	Neritina granosa.
Oúnaúna alealee	A coiled shell	8 to pound (e)	
Pa	Pearl oyster	20 to pound, meats	Melina costellata.
Pupu	Sea-snail		Ricinula horrida.
Wana (with long spines)	Sea-urchin	4 to pound (e)	
Wi	Limpet	60 to pound	
Miscellaneous.			
Frogs		7 ounces	
Honu	Turtle	15 pounds (e)	
Ea (not edible)	do		
Kohola	Whale		
Palaoa	Sperm whale		
Limu	Algæ		
Loli	Bêche-de-mer		
Naia	Porpoise	60 pounds (e)	

GENERAL STATISTICS.

The three tables below show in a condensed form, by islands, the persons employed and nationality of same, the boats, apparatus, fish ponds, and shore and accessory property used in the fisheries, and the catch by species, together with the value of same.

Table showing by islands and nationalities the number of persons engaged in the fisheries in 1903.

Nationality.	Hawaii.	Kahoolawe.	Kauai.	Lanai.	Maui.	Molokai.	Niihau.	Oahu.	Total.
Americans	10		4						14
Chinese	16		19		6	6		197	244
Hawaiian men	314	5	223	22	114	290	12	380	1,360
Hawaiian women	77		14		54			153	298
Italians								3	3
Japanese men	406	4	54		80	4		684	1,232
Japanese women								23	23
Portuguese	4							3	7
South Sea Islanders					25			35	60
Total	827	9	314	22	279	300	12	1,478	3,241

Table showing by islands the boats, apparatus, fish ponds, and property used in 1903.

Item.	Hawaii.		Kahoolawe.		Kauai.		Lanai.		Maui.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Boats	260	$18,970	3	$225	71	$4,880	20	$2,500	94	$8,985
Apparatus:										
Seines	22	4,850	2	250	21	5,585	17	350	30	1,290
Gill nets	43	1,460			35	324	2	16	30	750
Bag nets	22	715			2	300			49	1,865
Cast nets	124	620			20	200			25	200
Dip and scoop nets	22	110			12	24			25	55
Lines		1,226				133		50		272
Baskets (fish)									38	380
Baskets (opai)	42	21			16	12			15	15
Traps or pens					13	185				
Spears	95	95			4	8			31	41
Snares	4	3								
Fish ponds	3	1,500			2	1,900	1	700	1	2,500
Shore and accessory property		8,342		150		1,550		90		2,158
Total		37,912		625		15,101		3,706		18,511

Item.	Molokai.		Niihau.		Oahu.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Boats	78	$6,165	10	$750	431	$38,325	967	$80,800
Apparatus:								
Seines	57	2,355			25	1,570	[a] 174	16,250
Gill nets	84	1,440			496	10,350	[b] 690	14,340
Bag nets	11	1,450			29	1,930	113	6,260
Cast nets	52	520	7	70	80	800	308	2,410
Dip and scoop nets					133	349	192	538
Lines		50		30		1,182		2,943
Baskets (fish)					50	500	88	880
Baskets (opai)					47	21	120	69
Traps or pens					3	1,500	16	1,685
Spears	24	24			56	56	210	224
Snares							4	3
Pots					2	20	2	20
Fish ponds	12	4,050			67	154,900	86	165,550
Shore and accessory property		1,100		20		3,835		17,245
Total		17,154		870		215,338		309,217

[a] 15,859 yards. [b] 44,467 yards.

Table showing by islands and species

Species.	Hawaii.		Kahoolawe.		Kauai.		Lanai.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'alaihi	15,611	$156						
A'awa, fresh	3,255	433					300	$108
A'awa, dried								
Áhaáha	1,371	69					40	4
Ahi	58,205	2,386			2,750	$175		
Ahólehóle	3,900	342			1,013	104	50	5
Aku, fresh	118,170	4,727			11,420	1,144	1,366	55
Aku, dried	48,000	1,920						
Akule, fresh	482,369	23,858	18,000	$1,080	103,116	6,482	41,483	1,141
Akule, dried	20,500	1,105						
Ama-ama	3,608	732			123,058	11,982	10,075	1,612
Auau	1,068	22						
A'uku	1,000	40						
Awa	756	84			6,360	464	500	40
Awa-awa	316	31			2,390	207	212	25
Awela	175	18						
Aweoweo	1,879	120					90	10
Carp					3,100	186		
China-fish								
Gold-fish								
Ea, dried								
Ehu					1,200	116		
Hapú'upú'u	781	127					1,250	167
Haúliúli, fresh	11,600	928					220	22
Haúliúli, dried	9,100	455						
Híhimánu	1,560	126			260	19	120	6
Hilu	88	5					100	8
Hínaléa	889	45						
Húmuhúmu	9,338	278			1,035	100	2,178	109
Iheíhe	5,304	798			7,100	1,775	55	13
I'i								
I'iáo	900	14					3,750	60
Kahála	24,040	1,202					6,000	405
Káku	36	3			1,050	79	40	2
Kála, fresh	333	28			1,706	152	190	15
Kála, dried								
Kálekále	13,316	1,332					425	43
Kananío							100	5
Káwakáwa	56,037	2,932			5,255	419	4,100	523
Kawelea	5,406	892						
Kihikihi								
Kóle	209	20						
Kumu	3,033	399	500	50	2,900	280	300	49
Kupipi	67	6						
Kupóupóu							50	13
Laeníhi	543	4	2,000	100			5,000	500
Laè	4,220	253					100	3
Laipála								
Lauhu	1,785	89						
Lupe	5,350	321						
Máhimáhi	18,599	1,488					1,476	81
Maii'i	32	4					20	2
Maikoíko	143	11						
Maka'a								
Malámaláma							40	2
Malolo	618	155						
Mamámo								
Maníni	4,183	337						
Mano	4,997	111			640	38	120	12
Maumau								
Mikiáwa	25	3			170	13		
Moáno	66,280	7,954	200	10			2,088	501
Moelua							164	16
Moi	6,779	1,085	6,100	183	22,326	2,752	5,600	660
Mu	24	2	200	28			125	30
Nehu	1,030	16					8,750	158
Nenue	496	79			2,225	190		
Nóhu	1,644	164						
Nunu	245	9						
Ohua								
O'ílilepa								
Oío	48,179	7,709			25,570	2,372	420	32
Olali								
Omakaha	1,378	413						
Omilu								
Ono	13,968	698					2,700	1,080
Oópu					11,250	1,430		
Oópuhúe	285	57						
Oópukái	1,054	53						
Opakapaka					600	140	2,908	291
Opélu, fresh	33,792	6,084			850	60		

the yield of the fisheries in 1903.

Maui.		Molokai.		Niihau.		Oahu.		Total.	
Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
3,346	$261	2,200	$176			10,661	$855	31,818	$1,448
2,196	659	900	325	100	$10	6,051	908	12,802	2,443
				300	30			300	30
1,280	64					4,609	369	7,300	506
30	2	200	10			92,130	7,270	153,315	9,843
10,450	547	1,600	144			16,944	1,316	33,957	2,488
57,978	2,174	18,000	675	3,600	360	501,914	20,077	712,448	29,212
				1,000	100			49,000	2,020
267,882	6,000	73,328	1,930			404,051	33,862	1,390,229	74,353
								20,500	1,105
40,008	7,857	57,661	14,415	3,100	310	477,195	95,439	714,705	132,347
272	20					232	23	1,572	65
200	24							1,200	64
8,888	1,722	3,800	308			282,111	28,416	302,415	31,034
1,936	430	200	24			41,358	12,407	46,412	13,124
						162	16	337	34
10,449	801	900	104			51,021	3,571	64,339	4,609
						400	32	3,500	218
						1,090	323	1,090	323
5,443	272					8,042	659	13,485	931
				600	60			600	60
								1,200	116
5,372	716	600	80			64,245	8,352	72,248	9,442
1,335	168							13,155	1,118
								9,100	455
835	209					3,725	149	6,500	509
5,813	390	100	8			3,220	129	9,351	540
10,407	591	1,900	380			8,147	325	21,843	1,341
9,636	482	8,100	405			8,030	241	38,817	1,615
2,473	594	4,300	892			30,717	3,686	49,949	7,758
600	60							600	60
6,750	107							11,400	181
19,989	345	1,200	69			34,144	1,405	85,373	3,426
2,900	363					7,246	870	11,272	1,317
3,466	227	6,200	496	200	20	31,041	2,070	43,136	3,008
				400	40			400	40
223	17	75	8			155	8	14,194	1,408
212	21							312	26
32,468	5,084	6,300	803			61,554	15,388	165,714	25,149
489	150	80	40			1,185	178	7,160	1,260
						92	5	92	5
28,000	224					73	29	28,282	273
6,779	1,076	13,050	2,137			70,045	14,615	96,607	18,606
78	1					112	14	257	21
1,527	382	290	73			155	31	2,022	499
6,897	218	250	25			18,190	1,819	32,880	2,666
11,132	888	1,100	38			4,927	392	21,479	1,574
1,730	311							1,730	311
724	85	1,200	72			174	22	3,883	268
								5,350	321
10,678	508	700	39			33,138	5,965	64,591	8,081
1,565	188					4,060	365	5,677	559
		100	6			1,159	70	1,402	87
						301	120	301	120
12	1							52	3
		650	33			34,907	3,490	36,175	3,678
175	8					969	97	1,144	105
2,230	139	4,700	376			24,000	1,928	35,113	2,780
865	30	300	60			9,300	93	16,222	344
400	72							400	72
300	30					2,1$8	106	2,683	152
28,412	3,478	4,700	1,128			55,290	4,976	151,970	18,047
592	148							756	164
8,723	1,051	195	23	1,000	150	58,996	1,770	109,719	7,674
147	15	25	6			226	7	747	88
98,650	1,817	750	14					109,180	2,005
48,060	7,185					2,851	713	53,632	8,167
520	26	500	125			1,770	230	4,434	545
802	64	2,100	140			9,105	455	12,252	668
300	75							300	75
56	7							56	7
92,160	27,498	16,200	1,215	5,000	500	22,683	2,896	210,212	42,222
600	60	820	82					1,420	142
						1,609	290	2,987	703
						18,430	1,474	18,430	1,474
10,520	421	600	25			16,450	1,452	44,238	3,676
14,742	470					11,313	975	37,305	2,875
								285	57
105	8	150	20					1,309	81
9,434	2,358					7,612	813	20,554	3,602
104,948	15,742	1,300	156			131,846	15,822	272,736	37,864

Table showing by islands and species

Species.	Hawaii.		Kahoolawe.		Kauai.		Lanai.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Opélu, dried	5,000	$200						
Opule	349	35					80	$40
Páka	3,008	250						
Pakaikawale								
Pakii	8,590	859						
Paláni	510	21						
Panuhúnuhú	71	18					144	22
Páopáo							70	21
Pauú	7	2						
Pihá							2,500	40
Póopá'a	697	56					242	24
Pooú	951	159					182	22
Poupou								
Puálu	1,122	56	100	$5			170	22
Puhi	26,497	2,119			625	$55	300	45
Úhu	1,653	138						
Úku	3,475	695			1,400	140	7,000	1,505
Ukikiki							82	8
Uláe	30	2					80	8
Ulaula, fresh	17,308	4,842			8,100	790	590	295
Ulaula, dried								
Ulua, fresh	151,051	12,277			23,477	2,197	15,786	1,054
Ulua, dried								
Umaúmaleí	42	12					190	38
Uouóa	588	59						
Upapálu	1,196	179					20	2
U'u	19,944	1,033					258	23
Uwau	53	11						
Wálu							300	45
Weke	4,462	295			440	44		
Welea								
Conch								
Frogs	2,400	500						
Hee, fresh	14,836	2,195			600	75		
Hee, dried	7,000	914			1,200	150		
Honu	475	24			350	16		
Ina								
Leho	50	3						
Limu	1,425	156			1,710	212		
Loli	200	20						
Muhee							70	35
Olepe								
Opae	1,573	189			1,500	140		
Opihi	587	66			600	120		
Papai	3,971	238					100	12
Pupu								
Ula	6,326	646						
Wana	1,458	146						
Wi	20	2			600	120		
Total	1,404,794	101,149	27,100	1,456	377,946	34,738	130,669	11,069

the yield of the fisheries in 1903—Continued.

Maui.		Molokai.		Niihau.		Oahu.		Total.	
Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
								5,000	$200
1,315	$658	750	$375			1,821	$291	4,315	1,399
1,500	125	555	46					5,063	421
1,000	200							1,000	200
3,618	1,345	2,250	1,050			1,006	100	15,464	3,354
1,785	109	5,500	315			10,376	779	18,171	1,224
514	130							729	170
543	18	800	240					1,413	279
								7	2
5,600	88							8,100	128
727	18					7,380	443	9,046	541
545	50					600	24	2,278	255
200	20							200	20
356	38	200	25			38,600	2,895	40,548	3,041
12,242	2,027	3,700	577			22,915	1,046	66,279	5,869
24	2	4,200	700			24,884	3,980	30,761	4,820
29,892	6,405	1,000	215	2,900	$290	8,997	2,699	54,664	11,949
								82	8
991	11					1,082	64	2,183	85
614	129	1,100	550	800	80	7,951	3,975	36,463	10,661
				1,000	100			1,000	100
96,646	6,046	10,600	636	3,000	300	155,000	11,100	455,560	33,610
				6,200	620			6,200	620
80	8	100	20			458	36	870	114
						10	1	598	60
500	75	113	11			1,587	476	3,416	743
3,297	150	444	36			98,000	7,840	121,943	9,082
								53	11
3,080	168							3,880	213
3,017	169	1,930	120	400	40	110,000	8,200	120,249	8,868
9,760	1,504	510	128					10,270	1,632
430	108							430	108
								2,400	500
17,018	2,407	2,300	150			56,522	3,321	91,276	8,148
								8,200	1,064
440	17	250	8			2,520	378	4,035	443
1,100	110					3,000	360	4,100	470
900	225							950	228
1,525	381					41,000	1,025	45,660	1,774
300	75							500	95
47	24	105	13			96	48	318	120
						300	24	300	24
2,700	324					6,825	1,248	12,598	1,901
1,646	411					70,200	10,530	73,033	11,127
926	67	200	24			75,077	5,225	80,274	5,566
175	35							175	35
3,573	1,070	400	65			71,115	7,475	81,414	9,256
3,600	576					5,177	828	10,235	1,550
								620	122
1,212,445	120,267	274,331	32,389	29,600	3,010	3,515,850	373,819	6,972,735	677,897

Hawaiians are in the lead in the industry, 1,658 being so engaged. The Japanese are second with 1,255, followed by the Chinese with 244. South Sea Islanders, Americans, Portuguese, and Italians follow in the order named. The island of Oahu leads in the number of fishermen, with 1,478, Hawaii is second with 827, followed by Kauai, Molokai, Maui, Lanai, Niihau, and Kahoolawe, respectively.

The total investment in the fisheries amounted to $309,217. Of this Oahu has $215,338, or more than two-thirds of the total investment. Hawaii is second with $37,912. Oahu leads in the number of gill nets, dip and scoop nets, baskets, and fish ponds operated; Hawaii in the number of cast nets, spears, and in the value of lines; Kauai in the number of traps or pens; Maui in the number of bag nets, and Molokai in the number of seines.

The total catch in the islands was 6,972,735 pounds, valued at $677,897. Of this Oahu furnished 3,515,850 pounds, worth $373,819, or more than one-half of the grand total. Hawaii was second so far as quantity is concerned, but was exceeded in value of catch by Maiu. Kauai was third, followed by Molokai, Lanai, Niihau, and Kahoolawe.

So far as quantity is concerned, the akule was the most important species, 1,410,729 pounds, valued at $75,458, having been secured. The ama-ama had the greater value, however, the 714,705 pounds of that fish being worth $132,347. Aku was second in quantity and sixth in value of catch, with 761,448 pounds, worth $31,232. Other important species were ulua, awa, opélu, oío, káwakáwa, ahi, kumu, moi, awaawa, hapú'upú'u, u'u, weke, opihi, hee, papai, and ula.

The only species occurring in the commercial fisheries of all the islands is the moi. The ama-ama, kála, oío, úku, ulaula, and ulua occur in all but Kahoolawe, while the akule and kumu occur in all but Niihau. The china fish, kihikihi, maka'a, omilu, and olepe occur only in the fisheries of Oahu; the i'i, laípala, maumau, ohua, o'ílilepa, pakaikawale, poupou, conch, and pupu only in Maui; the lupe, oópuhue, paué, uwau, and frogs only in Hawaii; the ea only in Niihau; the ehu only in Kauai, and the úkikíki only in Lanai.

COMPARISONS WITH 1900.

The table below presents a comparison of the extent of the fisheries in 1900 and in 1903. All of the islands except Lanai and Maui show increases in the number of persons employed, the gain in Molokai alone being 134 per cent. The net increase in persons employed on all the islands is 896, a gain of 38 per cent. In the matter of capital invested every island shows an increase, that of Niihau alone being 170 per cent. The net increase of capital is $36,626, or 13 per cent. All the islands but Kauai, Lanai, and Molokai show increases in quantity of products taken; the decreases in Lanai and Molokai are quite heavy, being 38 per cent in Lanai and 27 per cent in Molokai; Oahu

shows an increase of 28 per cent. The net increase in quantity is 750,280 pounds, or 12 per cent. In value of products secured there is a decrease reported from every island. (As Kahoolawe had no commercial fisheries in 1900, there are not figures for comparison.) These decreases are considerable in each case, the lowest being in Hawaii, 26 per cent. The net decrease in value amounted to $405,749, or 37 per cent. For some years preceding 1901 the islands had been enjoying a boom, owing to the high prices realized for sugar, the dominant crop, and as a result the prices of everything else, fish included, rose exceedingly high. From 1900 to 1904, however, the price of sugar steadily declined, causing financial distress in every quarter, and curtailing very materially the purchasing power of the people. As a result the prices of the necessaries of life, particularly fish, have fallen to a point more nearly consonant with those prevailing on the mainland.

The prices of fishery products in 1900 were extremely high, and are still much above the normal. In the New England States in 1898 the average price per pound received by the fishermen for all kinds of fishery products was about 2.5 cents; in the Middle Atlantic States in the year 1901, about 2.1 cents; in the Gulf States in the year 1902 about 3 cents; in the Pacific Coast States in the year 1899 about 3 cents; and in the Hawaiian Islands in the year 1900 about 17.5 cents. In 1903 the average price had dropped to about 10 cents per pound. If the prices are not sustained by monopolistic combinations, as is the case at present in certain markets of the islands, they will drop even lower and thus bring fish into more general use as an article of diet.

Comparative table showing the extent of the fisheries of the Hawaiian Islands in 1900 and 1903.

PERSONS ENGAGED

Island.	1900.	1903.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Hawaii	549	827	+278	+ 50.64
Kahoolawe	....	9	+ 9	+100.00
Kauai	207	314	+107	+ 51.69
Lanai	46	22	− 24	− 52.17
Maui	297	279	− 18	− 6.40
Molokai	128	300	+172	+134.38
Niihau	12	12	....	....
Oahu	1,106	1,478	+372	+ 33.63
Total	2,345	3,241	+896	+ 38.21

CAPITAL INVESTED.

Island.	1900.	1903.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Hawaii	$25,172	$37,912	+$12,740	+ 50.61
Kahoolawe	....	625	+ 625	+100.00
Kauai	10,764	15,101	+ 4,337	+ 40.29
Lanai	3,478	3,706	+ 228	+ 65.55
Maui	15,171	18,511	+ 3,340	+ 22.02
Molokai	17,140	17,154	+ 14	+ .08
Niihau	322	870	+ 548	+170.19
Oahu	200,544	215,338	+ 14,794	+ 7.38
Total	272,591	309,217	+ 36,626	+ 13.44

Comparative table showing the extent of the fisheries of the Hawaiian Islands in 1900 and 1903—Continued.

PRODUCTS.

Island.	1900.	1903.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
	Pounds.	*Pounds.*	*Pounds.*	
Hawaii	1,304,311	1,404,794	+100,483	+ 7.70
Kahoolawe		27,100	+ 27,100	+100.00
Kauai	403,521	377,946	− 25,575	− 6.34
Lanai	212,628	130,669	− 81,959	− 38.55
Maui	1,159,117	1,212,445	+ 53,328	+ 4.61
Molokai	376,255	274,331	−101,924	− 27.19
Niihau	29,525	29,600	+ 75	+ .03
Oahu	2,737,198	3,515,850	+778,652	+ 28.45
Total	6,222,455	6,972,735	+750,280	+ 12.05

VALUE OF PRODUCTS.

Island.	1900.	1903.	Increase (+) or decrease (−).	Percentage of increase (+) or decrease (−).
Hawaii	$137,734	$101,149	−$36,585	− 26.56
Kahoolawe		1,456	+ 1,456	+100.00
Kauai	89,993	34,738	− 55,255	− 61.40
Lanai	29,853	11,069	− 18,784	− 62.92
Maui	190,929	120,267	− 70,662	− 37.01
Molokai	67,599	32,389	− 35,210	− 52.09
Niihau	5,623	3,010	− 2,613	− 46.47
Oahu	561,915	373,819	−188,096	− 33.47
Total	1,083,646	677,897	−405,749	− 37.44

IMPORTATION OF FISHERY PRODUCTS.

With the exception of a small portion of the white population, the inhabitants of the Hawaiian Islands are great consumers of fishery products. The domestic fisheries at present are totally inadequate to the demand, and as a result enormous quantities of fresh, canned, salted, smoked, dried, and pickled fishery products are imported each year. Owing to the unusual admixture of races, the imports are very diverse. Dried abalone, cuttlefish, oysters, seaweed, and shrimp are consumed by the Japanese and Chinese; dried and salted cod, haddock, hake, and pollock by the Portuguese and Porto Ricans, and salmon by the whites and natives.

The United States has always furnished more goods than any other country, but since the annexation of the islands, June 14, 1900, this has become domestic traffic, and, no records having been kept at the custom-house of the receipts from the mainland, it is impossible to show in figures the immense preponderance of this part of the trade. According to official data, during 1897, 1898, and 1899 the United States furnished almost two-thirds of the imports, and, judging from the statements of importers and others well informed, this proportion has been very radically increased since the annexation. As the United States tariff law replaced that of the late Hawaiian Republic, and was higher than the latter, foreign products were under a greater disadvantage in competing with goods from the mainland than was the case under the provisions of the reciprocity treaty.

The table below shows, by countries, the importation of fishery products during the calendar years 1901, 1902, and 1903. Japan has been rapidly forging to the front in this trade, which is not surprising when one considers the rapid increase in the number of Japanese on the islands during recent years. In 1897 the total importations from Japan amounted to $11,242; in 1898, to $14,382; in 1899, to $30,862; in 1901, to $53,596; in 1902, to $54,110, and in 1903, to $67,249. In the latter year the Japanese trade amounted to more than one-half that of all foreign countries. China is now in second place, although for a long time its trade exceeded that of Japan. In 1897 the total imports from China amounted to $24,674, while in 1903 they amounted to $18,081. A considerable part of this Japanese and Chinese trade could be secured by the islands and on the Pacific coast if efforts were made to prepare the peculiar products of which these two nationalities are especially fond, such as dried abalone, bêche-de-mer, oysters, cuttlefish, shrimp, and seaweed. A beginning has already been made in this direction in both sections, and it is very probable that the industry will soon be materially extended. Nova Scotia, British Australasia, Germany, Belgium, British Oceania, England, Portugal, Scotland, and Norway, in the order named, follow in importance of their fishery trade.

Table showing by countries the imports of fishery products during the calendar years 1901, 1902, and 1903.

Country and product.	1901.		1902.		1903.	
	Number.	Value.	Number.	Value.	Number.	Value.
Belgium:						
Anchovies and sardines				$1,351		$647
Fish, pickled and preserved				51		
Total				1,402		647
British Australasia:						
Fish, cured and preserved		$3,663		2,201		1,930
Shells, unmanufactured		13				
Shell and mother-of-pearl, manufactures of						1,662
Total		3,676		2,201		3,592
British Columbia:						
Fish (except salmon)—						
Fresh		281		38		
Pickled		50		493		102
Herring, pickled or salted ... pounds	750	20	2,400	114		
Salmon—						
Fresh ... do	4,453	227	427	20		
Pickled ... do	1,600	59	3,100	186		
Total		637		851		102
British East Indies:						
Shrimp and other shellfish and turtles				909		
British Oceania:						
Shells, unmanufactured		3				20
Shell and mother-of-pearl, manufactures of						534
Total		3				554

Table showing by countries the imports of fishery products during the calendar years 1901, 1902, and 1903—Continued.

Country and product.	1901.		1902.		1903.	
	Number.	Value.	Number.	Value.	Number.	Value.
England:						
Anchovies and sardines		$2,506				
Fish, cured and preserved		986		$345		
Total		3,492		345		
Germany:						
Anchovies and sardines		3,937		2,249		$2,214
Fish—						
Cured and preserved		21		476		81
Pickled		660				
Shell and mother-of-pearl, manufactures of						46
Total		4,618		2,725		2,341
Hongkong [China]:						
Anchovies and sardines		7		154		
Fish (except salmon), fresh		42		258		
Fish, cured and preserved		18,212		11,022		9,754
Herring, pickled ... pounds			150	3		
Oil, whale and fish ... gallons	27	8	24	4		
Shells, unmanufactured						1
Shrimp, other shellfish, and turtles				5,889		8,326
Total		18,269		17,330		18,081
Japan:						
Anchovies and sardines		2				15
Cod, haddock, hake, and pollock, salted, pounds			270	9		
Fish—						
Fresh		65				
Cured and preserved		53,528		48,693		43,797
Herring, smoked ... pounds					105	4
Mackerel, pickled ... do					765	21
Salmon, pickled ... do			606	28	1,760	70
Oil, whale and fish ... gallons			4	2		
Shells, unmanufactured		1		4		6
Shell and mother-of-pearl, manufactures of						8
Shrimp, other shellfish, and turtles				5,374		23,333
Total		53,596		54,110		67,249
Norway:						
Fish, pickled and preserved						45
Nova Scotia:						
Anchovies and sardines		3				
Cod, haddock, hake, and pollock, dried, salted, smoked, and pickled ... pounds	156,800	6,630	156,800	6,343	112,000	4,600
Herring, pickled or salted ... do	300	16				
Mackerel, pickled or salted ... do	850	68				
Salmon, pickled or salted ... do	570	48				
Total		6,765		6,343		4,600
Portugal:						
Anchovies and sardines				474		
Scotland:						
Fish, pickled and preserved						94
Samoa:						
Shells, unmanufactued		10				

The following table shows the fishery products imported into the islands during the calendar years 1901, 1902, and 1903, and indicates a progressive increase over former years for which data are available. In 1897, 1898, and 1899 the total foreign imports (exclusive of those from the United States) amounted to $49,688, $55,405, and $74,528, respectively; in 1901 they were $91,066, in 1902 $86,690, and in 1903 $97,305. Fish cured and preserved (mainly dried fish from Japan)

forms more than one-half of the total. Shrimp and other shellfish (mainly dried shrimp, oysters, and abalone from Japan and China), and turtles occupy second place, while cured cod, haddock, hake, and pollock are third. There has been considerable falling off in the imports of anchovies and sardines, while imports of canned mullets have ceased altogether, the latter not being able to compete with the cheaper grades of canned salmon from the United States since the annexation of the islands:

Table showing the imports of fishery products during the calendar years 1901, 1902, and 1903.

Product.	1901.		1902.		1903.	
	Number.	Value.	Number.	Value.	Number.	Value.
Anchovies and sardines		$6,455		$4,228		$2,876
Cod, haddock, hake, and pollock, dried, salted, smoked, and pickled ... pounds	156,800	6,630	157,070	6,352	112,000	4,600
Fish, cured and preserved		76,410		62,737		55,562
Fish, (except salmon):						
Fresh		388		296		
Pickled and preserved		710		544		241
Herring:						
Pickled or salted ... pounds	1,050	36	2,550	117		
Smoked ... do					105	4
Mackerel:						
Pickled or salted ... do	850	68			765	21
Salmon:						
Fresh ... do	4,453	227	427	20		
Pickled or salted ... do	2,170	107	3,706	214	1,760	70
Oil, whale and fish ... gallons	27	8	28	6		
Shell and mother-of-pearl, manufactures of						2,245
Shells, unmanufactured		27		4		27
Shrimp, other shellfish, and turtles				12,172		31,659
Total		91,066		86,690		97,305

EXPORTATION OF FISHERY PRODUCTS.

Owing to the immense domestic demand the islands have exported but little. Occasional lots of bêche-de-mer, sharks' fins, and gold-fish (for ornamental purposes) have been exported in the past, but not during the last few years. The table below shows the exports by countries for the calendar years 1901, 1902, and 1903. A record was kept at the custom-house of the exports to the mainland, and these have been included. Little, if any, of these exports were of domestic origin, but consisted mainly of transshipments and goods reshipped to the country of origin.

Table showing by countries the exports of fishery products during the calendar years 1901, 1902, and 1903.

Country and product.	1901.		1902.		1903.	
	Number.	Value.	Number.	Value.	Number.	Value.
British Australasia:						
Mackerel .... pounds..			10	$3		
Shells						$56
Total			10	3		56
British Columbia:						
Shellfish				13		
British Oceania:						
Salmon, canned					48	7
Hongkong:						
Fish						80
Japan:						
Fish						36
Shellfish						42
Total						78
United States (mainland):						
Caviar				30		65
Fish, dried, etc .... pounds..	710	$74		201		78
Herring .... do....			2,900	171		
Salmon, canned			23,120	1,218		3,714
Salmon		44				18
Shellfish		75		28		188
Shells		27				45
Total		220		1,648		4,208

THE FISH MARKETS AND THE FISH TRADE.

During 1903 there were 7 fish markets in operation on the various islands, 2 each at Honolulu (Oahu) and Hilo (Hawaii) and 3 at Lahaina (Maui). Since then several new markets have been opened in Honolulu, and the latter city is rapidly becoming one of the important fishery centers of the country. In the sections not accessible to the markets the people are supplied by peddlers, who carry their fish in small carts or on the backs of asses. Despite the rapid extension of this branch of the business during the last four years there is still great room for improvement, as many sections are without the opportunity of purchasing fresh fish, while others but rarely receive visits from the peddlers. A more strict supervision should be exercised over these peddlers, for they undoubtedly often sell stale and tainted fish.

HILO, HAWAII.

The retail market house at this place was quite fully described in a previous report. In August, 1901, an official fish inspector was appointed, a want which had long been felt because of the large quantities of tainted fish which the dealers had foisted upon the people. During the year 1903 there were employed in and around this market 23 Japanese and 4 Chinese.

Owing to the heavy surf in the vicinity of the market house, fishing-boats find it impossible to land here with their catch, and for some

years they made a landing on the beach at Waiakea, a suburb of Hilo and about 1½ miles from the center of the town. The dealers would gather on the beach at this place, and as fast as the boats arrived buy the fish and carry them to the market house. The conduct of this important part of the business in the open air was very trying at times, and eventually Messrs. Guard & Lucas, of Hilo, secured the necessary permit from the board of health and erected a small market house just inside the mouth of Waiakea River. This market house, with the land upon which it is located, cost $6,500, and was opened in August, 1902. The same people operate here and at the other market, as the principal part of the business is the buying of fish from the fishermen. As soon as a fishing-boat lands at the small wharf in front of the market the fish are brought in and dumped into one of the numerous bins scattered around the room. After being inspected they are looked over by the buyers, and when purchased are at once removed to make way for the next lot. A small commission on each sale is collected by the market owners. This market is also allowed to sell at retail, but this part of the business is insignificant, the town market proving the best retail selling place.

An inspector is in charge of both markets, and he has also an assistant at the Waiakea market. These men are supposed to inspect all fish before they are sold, and have the power to condemn any which they may consider unfit for food.

In order that the plantations along the railroad may be supplied with fish, the inspector permits a few of the more responsible dealers to carry fish from the Waiakea market and peddle them out to the people living on such plantations, who otherwise would be unable to get fish without making a special trip to Hilo for the purpose.

The tables given below show by months the number of each species of fish inspected in the markets of Hilo during the calendar years 1902, 1903, and 1904, inclusive. These are taken from the reports of the government inspector. One of the most interesting features of these tables is the possibility they afford of tracing the waxing and waning of the seasons of the migratory fishes, and the radical changes which sometimes occur among those apparently living permanently in Hawaiian waters. The figures on the mollusca, crustacea, etc., are far from complete, but the few data obtained have been shown in the tables.

Fish inspected in the Hilo market in 1902, 1903, and 1904.

1902.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
A'awa							541	283	4	97	1,116	
Ahi	16	1				3	7	91	56	91		
Ahólehóle	847	1,116	939	753	3,034	1,341	1,280	350	236	17	1,430	368
Aku					303	2,795	1,629	589	178	1		
Akule	15,003	3,790	2,150	22,142	32,595	70,915	66,865	7,919	943	3,513	1,779	667
Alaihi							159	127			561	
Anae	912	1,326	1,618	400	2,523	2,112	609	2,956	1,152	4,016	2,215	721
A'u	1											
Auau										5		
Awa	182	70	35	161	1,077		7	6			117	
Awela	7											
Aweoweo	426	83	16	322	1,023		211	569	151	176	628	198
Hahalalu	17,598	6,209	1,074	11,027	35,437	44,641	35,321	61,115	74,873	65,746	129,662	41,764
Hee (octopus)	34	6		12	10	3	33		39	3	32	29
Hilu							11					
Hinaléa							872		478	22		
Honu (turtle)		1							1			
Húmuhúmu	159	44		76	612	611	595	321	386	72	357	
Iheihe							85					
Kahála							46		4	3		
Káku												33
Kála	24						12	8	8		36	
Kalekale	563	52	36	465	1,454	637	641	445	2,316	919	585	181
Káwakáwa							21		2,605	4,343		
Kawelea	92	25			240	406	157	162	643	166	182	163
Kihikihi									2			
Koá'e	200	9						20				
Kumu	160	56	20	150	758	57	144	112	29	84	316	64
Kupipi						45			1			
Lae	16	7	2	22	271	2,108	42	60		8	267	87
Laenihi	48	33			441	71	78	16	21		109	
Lupe									1			
Mahi										2		174
Máhimáhi	26	1					5		22	58	33	
Maikoiko	249	113	171	155	236	337	196	867	108	164	1,773	243
Manena							9	12	3			
Manini	241	116	184	301	686	552	777	1,236	152	156	420	412
Mano	18	9	23	40	45	43	117	126	137	192	305	223
Manononi				100								
Moano	1,276	684	100	2,588	1,933	848	3,125	2,061	3,053	693	971	319
Moi	453		136	480	2,939	1,744	1,367	372	483	28	2,007	92
Mu							7					
Muhee (squid)		3										
Nenue	70	5	16	7	32		70	76	70	94	195	17

Nóhu	7	4	9		12	12	42	44	13	4	34	2
Nukumomi	140	279	295	1,372	471		123	79	82			16
Nunu				16				6				
Oio	132	45	60	187			190	650	816	95	1,320	
Ono							6		3			
Omakaha	429	30	93							52		
Oópu	567	400	3,469	1,400	4,000	4,931	3,344	2,620	87	192	4,386	1,644
Oópukái		13		32	41							
Opélu	2,389	918	360	1,270	2,099	355	662	453	847	136,201	49,192	1,541
Opule	9							432	1		232	
Páka	178	46	13	735	456	336	177	586	41	199	683	212
Paláni				18			11	28				
Panuhúnuhú									3			
Papai (crab)	391			60	1,469	3,146	2,694	1,448	2,063	1,125	2,876	95
Papiopioulua	240	231	79	924	392				18,502	61		
Poopú		6					67		43	8		
Puhi	24	7	3	21	34	42	37	57	39	43	62	88
Úhu				9	186	386	27	16	16	17	70	9
Uku	32				96	14	18	95		83	131	48
Ula (crawfish)	96	36	54	50			14	25	26	253	91	78
Uláe	107	49	10	90	138		90	164		67	156	82
Ulaula	363	129	41	452	922	430	439	635	658	163		55
Ulua		37	12	20	22	65	94	103	58	321	186	544
Uouoa							39		291	67		
Uu	85	40	54	61	600	337	338	268	477	420	287	
Wana (sea urchin)							177		80	16		132
Weke	191	341	90	965	1,388	1,968	828	614	242	171	870	126
Fish condemned	156	139	0	0	0	709	901	159	116	2,235	2,373	124

1903.

A'alaihi	17	2	11			19	3	29	47	11	10	9
A'awa	201	75	633	213	551	185	83	906	159	258	446	630
Aha							3	317	265	1		
Ahaáha			41								460	11
Ahi	162	51	75	35	116	78	31	188	53	50	31	272
Ahólehóle	1,017	3,964	2,790	5,415	2,481	999	727	116	66	251	959	633
Aku	5				1	418	870	272	2	43	449	577
Akule	10,368	2,630	46,975	20,280	31,928	5,929	8,167	6,031	2,356	3,539	9,596	17,928
Alalaua											268	
Ama-ama	849	1,627	557	2,205	1,078	1,256	664	250		292	1,134	259
Au	3			1	1	3						
Auau	79	4	119	6	54	5						
Awa	2	6		12	4	8		7	2	1		
Awa-awa										22		
Awela				1								
Aweoweo	150	36	185	441	339	100	19	106	78	242	286	167
China-fish										1		
Hahalalu	3,521	6,469	6,613	2,653	4,013	206	2,578	36,607	21,407	88,481	5,464	3,533

Fish inspected in the Hilo market in 1902, 1903, and 1904—Continued.

1903—Continued.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Hapú'upú'u			1	5	4	2		4	7	3	5	
Hee (octopus)	30	12	33	17	32	44	46	90	103	42	42	91
Híhimanu				1			1	2	2	207		
Hiloa		1										
Hilu				5	10	4	5	1				
Hínaléa	138	16	183	394	599	354	182	453	63	114	230	119
Holu				1								
Honu (turtle)						1						
Húmuhúmu	97	22	193	107	243	90	49	343	37	168	143	155
Iheíhe		125	156	260	228	25	6	4	1	11		
Kahála	3	25	99	86	43	24	14	4	5	5	2	8
Kaioakawa			17									
Káku					1	2	1	1	2	2		
Kála	2	32	3	11	17	5	3	21	7	10		4
Kalekale	472	215	992	1,438	2,446	954	1,142	2,047	586	1,837	1,231	2,095
Kaoe		9										
Káwakáwa	37			24	58	7	9	235	25	83		39
Kawelea	196	32	331	36	140	47	219	224	43	537	296	570
Kihikihi				2		1	2	1				
Kóle									336			
Kumu	34	30	71	117	77	46	32	121	48	223	263	259
Kupipi		7	8	4	1	4	2					
Kupóupóu					6		1	1				
Lae	572	436	1,240	130	166	20	3	13	4	19	69	98
Laeníhi			11	26	39	17	21	88	19	66	20	186
Lupe	1	1	1	1	1					2		
Máhimáhi	138	51	20	7	9	5	27	50	70	65	33	23
Maií'i				73	12	2			2	8		
Maiko	105	5	36					18	10	12		
Maíkoíko				22	49	33	1	17				
Malaialena					6			3				
Malolo				4	2	5	4	3				
Malolopiliko				2	1							
Mamámo				7	6							
Manene				1					81			
Maníni	323	254	299	766	465	275	271	145	80	121	57	292
Mano	141	138	99	57	75	48	110	72	148	221	111	559
Moáno	1,725	495	2,587	1,297	3,419	794	432	6,873	1,348	3,139	2,405	2,784
Moi	2,521	406	1,218	657	773	496	105	178	55	49	145	176
Mu					2		1	1	2			
Muhee (squid)										81		26
Mukumuhuwuahanui				1								
Nenue	9	45	50	32	26	185	3	48	20	21	11	46
Nóhu		7	5	18	23	16		11	8	127	22	26

Nukumomi	38	10	17	296	308	2		3	26			
Nunu		3	3	1	23	1	1	6	3	10		8
Oama	80									2		
Oio	230	111	472	962	1,331	1,324	401	1,364	501	1,250	1,017	653
Omakaha	615		611	917	24	24	242	689	320	3,157	915	755
Ono	2	1		9	17	17	5	8	1	10		9
Oópu	820	57	247	1,078	688	556	478	679	400	520	100	80
Oópukái			179	201	515	420						
Opélu	591	13	800	453	93	520	86	184	116	1,836	1,157	287
Opule			200	14	136	5		10	4	2		
Paeaea				1								
Páka	48	7	46	44	44						17	195
Paki'i							13	42	18			
Pakuikui									1			
Paláni	2	6	11	9	1	40	4	19	12	4		2
Panuhúnuhú				34	9	4	6	7	2	5		4
Papai (crab)	280	1,178	3,144	8,711	2,933	700	1,428	1,418	714	567	1,719	1,040
Papiopio							23	1	99	42	32	439
Papiopioulua	148			388	171							
Pauú									96	1		
Pauulua	177	65	24									
Póopáa							118	582	126	78	111	102
Pooú	24	5	84	95	180	52	15	58	39	28	54	
Pualu				6			2			4		
Puhi	9	119	58	60	67	44	23	88	39	105	158	36
Uhu	32			9	7	2	47	88	159			207
Uku	8		5	13	20	18	8	59	13	14		8
Ula (crawfish)	39	17	43	122	54	69	46	62	35	58	104	6
Ulaapapa (crawfish)				2								
Ulae	7									66		17
Ulaula	174	375	829	1,003	702	335	33	259	476	530	1,157	1,285
Ulua	509	279	341	47	65	85	45	185	40	66	225	317
Umaúmalei				3	21			13		25		
Uouóa		44	208	386	211							
Upapalu			5	2				7		78		
Uu	10		64	302	172	64	56	295	1,203	1,038	541	530
Uwau							171	117	93	40		
Wana (sea urchin)				135	181	108	64	42	166	134		200
Weke	113	39	196	249	205	179	120	500	130	220	528	2,937
Fish condemned	341		214	354	281	292	130	123		120		

618 pounds of ophihi examined during the period.

Fish inspected in the Hilo market in 1902, 1903, and 1904—Continued.

1904.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Áalaihi		1	224	8	7	3	6	10	8	119	5	51
Á'awa	244	599	698	307	761	412	352	186	353	131	320	512
Aha							75	255	23	12		
Áhaáha	6		98	174	433							
Ahi		1	27	28	114	222	104	160	49	17	17	23
Ahóleh óle	515	1,175	2,461	2,526	410	1,103	865	517	517	3,317	2,340	596
Akilolo					3							
Aku	44				221	838	223	468	51	178	368	559
Akule	981	8,559	14,922	6,956	45,298	8,620	3,130	3,595	1,230	29	90	473
Alalaihou							3					
Alalaua			23									
Aloalo (prawn?)		6										
Ama-ama	1,291	658	169	617	555	1,213	415	88	142	326	514	230
Anae			594		777	500						
A'u					4							
Auau			77	68	19	36	37	20	49	23		17
Auae		255		1,873			1,928	730	373	570	938	456
Awa			2									
Awa-awa			1	4	7	7	24	10	12	30	3	1
Awakalamoku						25	2					
Aweoweo	49	253	174	74	134	81	43	92	154	68	256	442
Hahalalu	2,949	1,351	535	521	2,890	31,960	28,144	257,523	250,876	104,626	93,314	101,649
Hapú'u pú'u			6	2	7	4	22	19	18	33	8	5
Hauliuli								14	1	12	20	57
Hee (octopus)	59	61	62	29	49	23	50	50	45	77	24	121
Híhimánu			2	1	195		1	4	1		1	
Hiloa			1	4	1		1					
Hilu		1	4	8	4	2	4		3	1	2	2
Hinaléa	80	210	930	760	691	538	512	566	103	53	40	222
Honu (turtle)			16	1	2	2	1					6
Húmuhúmu	83	124	366	136	212	164	316	76	141	48	46	219
Iheihe		7	64	78	30	22	29	1		9	16	77
Kahála		2	77	15	27	6	2	9	7	3	3	12
Káku					1	3	1	2		1	2	2
Kála	4	3	14	4	10	7	20	4		9	21	6
Kálekále	554	278	703	528	1,123	740	546	837	1,748	3,705	1,353	661
Kaoe			4	54	46							
Káwukáwa	8	35	49	10	66	118	166	149	1,684	7,894	303	85
Kawelea	40	296	354	45	85	254	292	309	1,282	1,870	210	494
Kihikihi			4		6		2	7	3	1	16	2
Koá'e							33	58	34	28	30	20
Kole					24	27	2					
Kumu	35	137	54	129	51	49	28	60	47	26	34	131

Kupipi	5		8	49	9	10	3	1	6	8	2	1
Lae	2	121	777	27		23						
Lai							11	8	3	14	76	115
Laeníhi	17	120	85	47	45	46	70	20	55	82	49	255
Lar'hau								8				
Lupe			1		1	1		2	4		1	3
Máhimáhi		7	44	1		21	57	18	113	65	40	168
Maií'i	17	29		77	111	56	521			5	14	4
Maiko	61		45	39	151	100	177	2	24	12	19	150
Makáa										4		
Malaialena			7	6	7		1	15	5		14	2
Malolo				1		2		7	6	18		
Manene			11		1							
Maníni	546	680	636	551	667	207	177	65	196	221	82	471
Mano	87	39	49	9	20	12	166	70	47	73	105	306
Moáno	1,817	3,746	4,663	1,402	3,328	1,791	4,740	928	3,311	862	1,007	2,559
Moi	241	684	693	375	1,687	965	130	348	97	52	166	264
Mokumokuwahanui		2	5				1			4		
Mu			3	2	3	1	1		2	5	3	3
Muhee (squid)	2	2					9	22	39	44	2	6
Nama							5	3	25	58	153	30
Namu				9	20	2						
Nenue	19	47	254	34	248	46	46	50	68		29	72
Nóhu	12	11	22	22	25	11	14	10	65	49	33	35
Nukumomi			34		32							
Nunu	4	10	5	5	6	10	48	18	8	10	31	63
Oeoe							2	582	16	31		
Óililepa					15							
Oio	182	696	789	259	857	281	490	761	533	1,107	391	690
Omakaha	1,644	844	59	299	149	1,479						
Omaka							259	1,162	482	864	91	725
Ono				4	25	9	14	12	17	11	1	1
Oópu	117	12										
Oópukái		200	229	150	652	243	291	29	369	35	12	11
Opae								5				
Opakapaka				26	48	80	67	282	108	49	18	37
Opélu	87	46	201	214	86	228	230	1,481	749	47,577	361	624
Opule		11	10	1	6	6	26	2	2	2	1	7
Páka			30	5								
Paki'i					1							4
Pakuikui					1		4					2
Paláni			3	17	18	4	18	145	62	28	13	24
Panuhúnubú	20	2	12	4	3	1	9	2	4	4	6	3
Papai (crab)	907	1,302	979	1,140	775	1,624	2,936	2,663	1,145	492	927	578
Papaohe		6	15									
Papiopio	113	255	438	97	636	45	71	158	177	558	2,062	1,034
Pilikó'a						35						
Pohopoho							113	71	75	50		
Póopá'a	35	212	814	170	295	256	576	2	148	21	4	16
Pooú	40	53	109	26	91	23	71	18	23	33	6	23
Puálu			4				5		3	4	5	4
Puhi	26	33	94	29	83	24	93	64	23	35	53	91

Fish inspected in the Hilo market in 1902, 1903, and 1904—Continued.

1904—Continued.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Puhikii										2		
Úhu	75	29	17	2	43	18	204	135	66	4	1	62
Úku		2	18	6	18	22	38	29	17	7	2	7
Ula (crawfish)	83	51	235	123	188	132	179	121	68	156	23	118
Ulaapapa				2	4	4						
Uláe		13	18	5	7		7		11	10	9	11
Ulapapapa									7			
Ulaula	495	618	1,484	1,023	531	293	355	331	1,013	975	764	558
Ulua	17	11	94	45	168	107	398	311	296	290	242	682
Uouóa							236	107	203	207	144	53
Upapálu			580					40	8	1		23
U'u	17	99	468	69	152	31	236	416	394	324	154	405
Wálu												5
Wana (sea urchin)				45	121	20	71	249	45			
Weke	122	260	589	201	269	152	199	136	395	857	288	1,250
Fish condemned				308		681	521	2,010	1,007	850	1,039	616

LIHUE, KAUAI.

There is no regular fish market on the island of Kauai, but at Lihue the meat dealer handles fish whenever they are to be obtained. Other sections of the island are supplied by peddlers with small carts, who make occasional trips when the fisheries are being operated. Most of the fishermen are natives and, with their usual shiftlessness, refuse to resume fishing after a good haul until the proceeds have been expended, and often by that time the school of fish has worked off the coast and disappeared.

LAHAINA, MAUI.

The territorial government owns the principal market house at this place. It is a long one-story row, with its back overhanging the ocean, and, including the land, is valued at about $6,000. It contains six stalls, all of which are leased to natives and whites, but nearly all of these sublet to Japanese dealers. In 1903 there were 1 American, 2 natives, and 6 Japanese employed in this market.

Close by is a private market containing two stalls, the whole, including land, being valued at $700. Four Japanese operated this market in 1903.

Since the last investigation (1901) a new private market, composed of 4 small buildings, has come into use. It is valued at $400, including land, and is operated by 8 Japanese.

One of the worst features of the industry at Lahaina is the lack of inspection of the products sold in these markets. An inspector was put in charge in August, 1903, but owing to lack of money the board of health was compelled to dispense with his services in January, 1904, and at present the markets are as much without inspection as in the old days. This is a very unfortunate condition of affairs, as Lahaina is one of the most important fish-distributing centers of the islands. The greater part of the surplus fish from Molokai and Lanai is landed here, and by means of peddlers is distributed to the various sugar plantations of the island. Owing to the lack of proper inspection, large quantities of tainted fish are sold in these markets, or peddled throughout the surrounding country.

The Japanese have established a virtual monopoly of the handling of fish in this section of Maui. Nearly every stall in the various markets is operated by Japanese, who have formed an association or trust, by means of which they are enabled to force the fishermen to dispose of their catch to the association at whatever price the latter may see fit to offer. Many of the dealers are also financially interested in the boats and fishing gear of their fellow-countrymen, and as a result of this the native fishermen complain that they are grossly discriminated against, and are compelled to sell their catch for much less than is paid to their Japanese competitors. Should the native fisherman refuse to

sell to the association he is compelled to rent a stall in the market, should that be possible, and retail his catch. As the Japanese are the largest part of the fish-eating population and none of them will patronize other than his fellow-countrymen if it is possible to avoid it, the native finds it difficult, if not impossible, to sell more than a fraction of his catch at his own price, and is compelled eventually to sell what is left to the Japanese at a still lower figure than was offered in the first place, or else have it spoil on his hands.

The association regulates the prices at which fish are retailed in the markets, and even in times of a glut the low price does not benefit the consumer, although the fishermen receive less. Should there be an oversupply, the surplus is peddled around to the different plantations by Japanese with small carts.

There are serious inconveniences arising from these conditions other than the opportunity afforded for extorting exorbitant prices from the consumer. For three or four months of 1903 it was almost impossible for the people of Lahaina to buy any fish, because the association sent nearly all over to Spreckelsville, where they were sold to the Japanese at that place, presumably because better prices could be had there. This is likely to happen again at almost any time, and the people are thus at the mercy of an irresponsible association of alien dealers.

WAILUKU, MAUI.

At the time of the previous investigation there was a small market house here, owned by a private individual. It had only five stalls and was run principally by natives. Even this poor apology for a market ceased to exist in 1902, when it was transformed into stores, and since then the only means of securing fish has been from the peddlers who go from house to house on certain days in the week, or when there is a supply of fish landed from Molokai, or an extra large catch made at the Kahului fishery, a few miles away. It was not until the middle of 1903 that this section had a government inspector of fish, which it sorely needed, and even this boon was withdrawn January 1, 1904, owing to the low condition of the finances of the Territory.

HONOLULU, OAHU.

At the time of the first investigation there was but one fish market in Honolulu—the government market in the square bounded by Allen, Richards, Alakea, and Halekauwila streets. This building was erected in 1890 at a cost, including the value of the land, of $155,000, and is one of the handsomest and most conveniently arranged fish markets in the United States. During 1903 20 Chinese, 2 Japanese, 3 native men, and 3 native women were engaged in selling fishery products, while 1 superintendent (who acted also as fish inspector), 1 market

keeper, 1 assistant market keeper, 1 assistant fish inspector, and 1 laborer, were employed.

A serious competitor of the government market appeared on November 5, 1903, when a private market which had been constructed on Kekaulike street, between King and Queen streets, a former site of the government market, was opened for business. This market was constructed at an expense, including the value of the land, of $60,000. Like the government market, the greater part of it is devoted to the sale of fish, and the building is very conveniently arranged for this purpose. Many of the dealers in the government market left that place and took stalls in the new market as soon as it was opened, owing to the fact that it is more conveniently situated for catering to the Chinese and Japanese, who are the principal consumers of fish. During the short time the market was open in 1903 there were 96 persons—80 Chinese, 7 Japanese, and 9 natives—employed in and around it in marketing the fishery products. The government fish inspector has charge of the inspection of fish in this market also, and is assisted by a native man, the latter being paid by the owner of the market.

On February 6, 1904, a small market, containing six stalls, was opened at the corner of Beretania and King streets. An assistant fish inspector, paid by the owner of the market, is in charge, and works under the supervision of the government inspector.

A most comprehensive scheme for the marketing of fishery products was being worked out at the time of the present inquiry. A company was organized under the name of "The Inter-Island Live Fish and Cold Storage Company," and proposed to establish markets at convenient places within the city limits from which fish could be distributed expeditiously and without danger of loss from death and other causes incident to a tropical climate. Special means of water supply and refrigeration were provided, and every effort directed toward the preservation of the fish in fresh and wholesome condition as it reached the consumer.

Cold storage is undoubtedly necessary in such a climate as prevails in the islands. As the law stands at present all fish brought to the market up to noon must be sold before evening or else thrown away. Fish arriving at the market after noon and remaining unsold when the market closes can be placed in cold storage for the night and again offered for sale, but must then bear the printed legend "Iced fish."

The tables given below show, by months, the number of each species of fish inspected in the markets of Honolulu during the years 1902, 1903, and 1904, and, as in the case of the Hilo market reports, are taken from the official report of the inspector. Here, also, the figures for mollusks and crustaceans are incomplete.

Fish inspected in the Honolulu market in 1902, 1903, and 1904.

1902.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
A'alaihi	4,609	951	1,547	2,920	3,167	1,095	1,484	1,800	2,552	1,666	1,717	1,710
Á'awa	1,261	862	1,100	619	385	767	288	327	855	669	616	532
Áhaáha	1,033	799	252	58	113	245	143	252	139	499	1,319	181
Ahi	16	12	61	62	54	129	20	29	23	59	13	108
Ahóleħóle	8,562	5,613	8,188	5,509	8,027	11,473	1,102	661	1,837	818	1,780	3,570
Aku	1,094	1,528	2,802	3,549	5,495	15,714	6,820	4,358	4,071	11,492	1,556	2,263
Akule	24,380	16,029	17,880	22,809	16,716	25,853	6,302	6,410	1,511	2,420	5,359	2,144
Ama-ama	84,737	76,652	90,462	59,323	55,467	58,623	36,652	56,411	49,844	47,133	85,662	84,030
Awa	11,213	14,031	17,076	13,790	22,108	28,071	25,080	20,898	15,432	17,714	18,026	7,245
Awaawa	3,158	1,234	2,524	2,095	5,061	7,297	4,179	5,036	6,659	4,997	4,539	1,601
Awa kalamoku									16	17	23	20
Awela	1	10	29	8	18	4	9	11	30	17	15	39
Aweoweo	1,393	584	794	48	77	76	71	206	654	2,945	1,992	747
China-fish	35		10	94	26		6			3		1
Gold-fish	2,970	1,343	176	*310	1,715	1,505	420	3,350	2,367	2,120	517	1,490
Hahalalu		595						5,627	84,071	111,249	98,483	33,859
Hapú'upú'u	52	50	56	99	114	129	34	25	23	13	20	79
Haúliuli			11									
Hee (octopus)	1,270	867	1,186	971	760	1,398	1,202	2,433	3,468	2,412	2,216	1,530
Híhimánu	8	7	1	4	14	9	6	7	7	7	8	4
Hilu	62	85	78	46	27	34	14	18	64	52	35	56
Hínaléa	1,426	1,897	1,713	886	1,001	1,360	2,242	2,012	3,020	2,043	1,607	1,252
Honu (turtle)	6	7	19	24	13	15	14	34	23	22	11	6
Húmuhúmu	138	179	239	105	77	64	460	970	521	355	86	73
Iheíhe	2,422	2,597	734	20,452	997	2,176	1,113	3,131	1,517	453	283	242
Kahala	265	135	102	213	366	170	59	32	17	24	15	42
Káku	165	110	133	160	174	201	146	236	206	153	141	102
Kála	1,564	1,721	1,457	2,353	1,622	2,083	1,073	522	725	929	715	745
Káwakáwa	93	2,667	2,667	2,862	2,447	1,142	1,466	4,527	603	3,413	346	424
Kawelea	22	33	124	62	30	19	9	5	12	26	41	25
Kihikíhi		59		155						40		
Kóle	460	151			33	25				65	21	145
Kumu	1,502	1,318	1,318	1,143	1,069	848	1,122	947	1,628	1,151	1,382	1,366
Kupipí			12		5							
Kupóupóu			5					45		32	68	41
Lae	247	137	174	178	137	1,544	168	127	127	68	109	28
Laeníhi	585	344	295	178	185	252	1,084	3,025	1,368	1,136	857	458
Lauhau	170	85								46	7	7
Máhimáhi	12	11	12	22	173	190	174	418	398	125	140	96
Maii'i	1,957	918	302	27	383				375	1,185	597	902
Maiko	289	314	90	12	137	29						
Maíkoiko							10	6	83	71	69	555
Maka'a	52	10				38	152	823	454	289	47	41

Malolo				656	7,477	9,025	9,942	2,758	1,374	28		
Mamámo	377	266	95	26	280	6	71	49	100	585	155	523
Maníni	7,177	7,038	4,087	4,265	2,179	1,632	982	1,621	4,165	4,293	3,345	3,984
Mano	76	62	56	94	82	259	347	388	346	282	154	132
Mikiáwa	74			19	44							88
Moáno	5,340	5,485	8,232	5,873	4,943	7,877	9,230	10,778	12,533	10,199	7,969	5,959
Moi	1,172	1,340	2,674	1,881	3,766	3,684	1,164	3,761	2,372	4,361	7,940	4,599
Mu									13	37	3	1
Muhee (squid)	13	31	19					36	331	1,318	134	26
Naenae											2	
Nenue	96	66	102	77	139	303	146	76	309	454	298	43
Nóhu	25	7	8	5	9	14	4	7	9	1	1	11
Nunu	116	44	86	42	26	24	19	74	27	163	222	116
Oama									1,850	12,940	6,310	5,070
Oílilepa	5	8	8		13	16		13	4	5	5	
Oio	1,504	1,378	1,092	1,193	3,773	4,381	1,787	2,194	3,226	3,237	1,699	1,217
Omaka	260	437	3,421	225	438	397	231	440	1,680	294	228	36
Omilu	190	55	39	182	96	574	68	96	44	74	304	203
Ono	2		2	13	34	14	14	29	21	12	11	2
Oópu	385	614	1,438	1,618	1,115	680	527	200	80	360	1,120	752
Opakapaka	101	163	116	101	45	22	21	21	17	63	59	63
Opélu	7,142	3,343	5,946	9,051	8,758	5,140	6,942	16,705	30,507	17,339	34,384	28,898
Opule	340	291	165	38	181	44	23	24	59	172	170	402
Paki'i			66		30	330	266	253	115	74	36	30
Pakuikui	75	50							30			
Paláni	322	172	427	321	439	717	228	149	200	449	110	57
Panuhúnuhú		135										
Papai (crab)	8,043	5,013	3,043	2,356	3,185	3,320	2,832	8,510	12,296	7,316	7,788	5,736
Papíopio	1,945	1,100	1,059	189	197	849	13	2,690	9,700	10,074	5,134	698
Pauú	1,800	2,398	1,947	4,164	3,081	3,896	2,340	1,791	2,016	2,399	4,186	5,356
Póopáa	603	795	603	234	152	584	288	220	761	456	520	473
Pooú								51	10	31	100	30
Puálu	1,523	861	633	1,650	1,820	1,849	936	1,174	1,052	1,282	918	328
Puhi	248	260	248	389	177	175	153	249	241	264	328	273
Puhiki'i				4,631	13,015	1,920	23,366	28,629	5,225			
Úhu	526	625	231	1,347	1,872	1,454	287	109	220	407	273	251
Úkikíki			45	177	130	163	2,611	1,352	856	1,316	320	177
Uku	460	246	116	135	384	321	294	292	221	254	145	235
Ula (crawfish)	944	784	1,091	1,858	2,255	4,291	3,404	3,421	1,520	1,219	1,503	1,062
Uláe						195	140	100		14	25	
Ulaapapa (crawfish)		28	70	165	87	40	179	152	53	48	5	30
Ulaula	35	73	21	22	115	113	25	4	32	15	65	63
Ulua	297	576	305	422	612	861	831	486	514	700	418	347
Úmaúmaléi	389	257							20	50		30
Upapálu	1,697	1,092	211	359	254	161	3,188	851	687	1,999	1,455	1,244
U'u	6,062	3,376	1,321	1,731	605	1,083	5,074	6,890	7,101	8,919	7,215	10,994
Uwau										50		
Wálu	3	2	3	2		2		1		2		
Wana (sea urchin)	297	67	177	208	139	1,712	2,420	757	717	673	357	158
Weke	6,791	6,190	1,896	8,185	7,246	4,559	2,829	4,122	4,308	4,665	4,144	3,345
Fish condemned	1,304	3,054	3,883	2,190	912	3,295	1,409	1,148	7,627	5,293	4,988	1,726

Fish inspected in the Honolulu market in 1902, 1903, and 1904—Continued.

1903.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
A'alaihi	3,060	2,418	5,078	3,090	4,158	4,783	7,956	7,602	5,384	7,383	18,474	15,903
A'awa	314	277	1,178	274	616	1,256	788	953	458	436	776	744
Ahaáha	790	227	639	211	1,911	750	562	1,238	837	285	1,132	636
Ahi	199	293	456	402	212	168	92	52	13	5	65	114
Ahólehóle	4,003	4,039	7,693	7,950	9,667	4,475	2,698	5,721	2,787	2,849	5,552	7,184
Aku	1,944	3,268	3,791	6,249	6,276	3,547	3,919	8,182	2,027	1,896	3,040	7,563
Akule	2,759	2,268	12,287	29,154	39,638	27,767	22,819	14,721	6,996	5,726	9,986	20,484
Ama-ama	86,842	75,618	77,123	41,491	56,759	53,102	41,985	59,047	47.421	47,097	65,118	64,189
Awa	10,842	7,507	5,433	8,216	12,015	18,223	18,763	16,476	13,527	8,822	10,236	5,656
Awa-awa	1,194	1,110	1,570	1,794	2,371	2,640	2,811	4,072	2,792	2,841	3,344	1,035
Awa kalamoku	11	17	18	52	77	16	28	232	23	4	212	23
Awela	20	6	54	17	22	20	14	33	4	16	9	1
Aweoweo	910	308	1,008	712	671	172	257	779	2,777	5,230	15,550	9,653
China-fish	41	2	3	8	9	7			9		14	2
Gold-fish	3,191	1,565	2,639	1,858	4,306	2,855	2,703	3,839	3,445	2,508	3,369	261
Hahalalu	37,041	41,783	62,878	3,836	176	3		2,403	17,233	21,446	46,364	24,461
Hapú'upú'u	154	69	444	308	232	620	307	80	328	281	160	310
Haúliúli											1	8
Hee (octopus)	1,613	814	1,656	435	526	203	361	1,084	1,393	2,760	2,587	2,718
Híhimánu	13	2	11	11	11	17	1	2	8	11	10	2
Hilu	69	41	101	17	60	132	78	67	36	9	62	49
Hinaléa	1,329	1,068	2,262	601	1,373	2,061	2,217	2,932	1,529	1,882	2,581	2,754
Honu (turtle)	6	9	10	18	26	29	19	11	10	13	7	10
Húmuhúmu	76	100	90	286	555	966	494	640	484	324	622	455
Iheíhe	19,460	9,418	2,631	467	1,306	1,706	6,328	3,211	3,549	2,288	15,701	6,814
Ina (sea urchin)											1,520	350
Kahála	71	63	359	89	133	122	41	• 31	58	38	41	121
Káku	141	89	179	185	186	227	254	381	245	279	272	185
Kála	1,404	884	1,422	850	779	552	282	423	580	757	1,385	2,376
Káwakáwa	89	433	529	1,329	2,852	747	1,503	1,842	1,693	3,678	3,440	642
Kawelea	37	20	87	285	41	18	8	8	4	22	37	23
Kihikihi	25	5	50			20		7			232	121
Kóle	20	45	340	4		25		10	26	221	132	55
Kumu	1,891	1,421	3,484	1,813	1,975	1,661	2,090	1,716	1,900	1,633	5,566	3,347
Kupipi											7	49
Kupóupóu	105	71	122	12	29	105	59	134	60	55	253	51
Lae	164	50	418	481	538	202	274	231	607	246	372	155
Laeníhi	566	366	246	130	328	434	611	1,319	1,727	870	3,553	4,102
Lauhau	15		58	7	132		7	55		6	6	150
Máhimáhi	57	40	49	107	271	126	342	239	216	88	235	71
Maii'i	282	554	1,313	10	19	19	20	19	155	767	3,756	2,267
Maikoiko	27	112	258	12	14	5	3	23	53	483	487	441
Maka'a	121	53	80	10	67	161	34	354	510	92	235	292
Malolo			183	2,202	12,397	11,356	4,495	5,822	2,835	8	10	* 3

Mamámo	74	145	274	305	58	18	98	236	151	1,230	2,806	3,297
Manini	5,332	2,677	4,591	2,418	4,062	3,293	1,878	2,440	2,058	2,306	2,965	4,016
Mano	208	70	119	96	223	304	663	694	264	277	132	164
Mikiáwa	4	148	480		439	1,320	221	180	10	950	2,556	255
Moáno	5,155	4,992	9,915	7,170	11,534	12,421	11,215	14,770	6,874	7,425	18,820	15,599
Moi	4,412	5,842	6,104	2,942	3,047	2,346	1,847	2,701	2,342	1,672	4,690	7,051
Mu	19	12	3		10	10	66	24	17	18	31	16
Muhee (squid)	71	95	41	28	20	13	1	4	6	18	112	72
Naenae											35	67
Nenue	70	66	114	25	93	116	87	172	57	138	679	234
Nóhu	4	3	19	32	87	42	33	1	23	4	1	5
Nunu	274	146	116	199	216	115	100	122	146	559	3,883	1,229
Oama	11,140	4,068	6,381	1,336	270			31,750	67,295	25,485	26,707	22,735
O'ililepa	2		1	2	1	2	2	1	3		1	
Oio	2,026	770	3,241	1,716	1,820	1,750	1,708	2,431	2,039	14,367	1,240	2,259
Omaka	912	194	226	1,308	1,023	491	516	1,118	424	163	23	659
Omilu	152	53	1,027	57	58	108	96	259	222	305	200	149
Ono	17	5	40	30	39	31	21	30	19	30	32	35
Oópu	2,019	625	204	150	377	545	383	182	408	865	1,951	596
Opakapaka	35	30	179	113	77	119	103	47	143	127	157	773
Opélu	20,588	5,755	29,788	44,096	37,667	12,875	10,755	27,809	30,395	55,710	25,355	13,239
Opule	58	195	281	17	20	44	20	30	38	413	1,100	427
Paki'i	25	76	62	57	36	235	83	60	90	30	1,602	5,679
Pakuikui	45	91	5			4,390			44		13	57
Paláni	463	106	99	55	89	186	87	204	142	261	834	262
Panuhúnuhú											56	60
Papai (crab)	9,117	5,092	9,651	10,610	12,925	9,009	8,397	10,672	8,011	13,609	22,208	20,194
Papíopio	1,516	1,547	1,868	1,400	260	673	95	95	2,352	4,390	1,835	2,152
Pauú	4,992	1,579	2,815	2,753	3,815	2,739	1,937	2,589	1,486	1,354	3,419	8,046
Póopá'a	566	321	1,192	190	349	1,016	1,082	1,914	667	2,000	1,490	1,863
Pooú	50	55	28		68	48	15	48	55	15	18	
Puálu	1,135	349	804	292	1,094	1,461	1,068	1,495	1,566	1,073	2,543	2,366
Puhi	226	100	301	140	437	237	163	368	229	295	412	1,425
Puhiki'i	400	230		840	2,312	28,741	3,512	27,986	3,836	25	1,031	3,355
Úhu	223	132	643	93	1,482	1,331	231	315	61	217	633	327
Ukikiki	159	54	712	816	956	800	544	446	175	1,226	729	253
Úku	149	106	261	81	170	296	261	681	149	167	152	126
Ula (crawfish)	574	609	1,175	1,051	2,787	3,607	2,240	3,625	2,184	1,459	1,624	2,222
Ulaapapa (crawfish)	11	62	153	213	262	193	315	306	120	42	147	40
Uláe		7	65	60		247	33	145	142		154	2,393
Ulaula	84	64	377	486	549	241	136	165	25	23	125	128
Ulua	207	152	451	216	262	371	322	417	246	299	274	176
Úmaúmalei	2	25	41					8	37		184	161
Upapálu	1,420	599	585	227	431	1,021	2,044	1,651	2,346	3,628	5,195	2,704
U'u	5,885	3,793	3,556	1,724	1,508	4,147	10,178	9,581	26,167	32,126	40,701	17,657
Wálu	1		1			1			1			2
Wana (sea urchin)	574	359	952	329	846	1,815	1,001	1,407	1,241	1,708	1,887	2,590
Weke	3,556	4,174	8,953	9,538	11,297	6,993	6,434	7,844	5,640	7,151	27,660	18,663
Fish condemned	913	922	537	1,549	1,485	1,998	2,798	3,515	3,100	8,349	3,948	2,556

Fish inspected in the Honolulu market in 1902, 1903, and 1904—Continued.

1904.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
A'alaihi	4,772	2,019	6,128	6,267	4,010	2,755	3,983	5,274	18,443	17,364	10,312	5,993
A'awa	692	259	621	665	612	244	496	1,394	822	1,893	1,268	866
Ahaáha	246	562	1,117	512	647	428	425	516	357	3,186	5,132	4,104
Ahí	123	226	426	169	47	143	211	98	170	38	545	1,761
Ahólehóle	10,275	6,956	5,309	6,606	4,134	3,174	6,126	10,140	0,340	18,374	14,544	7,319
Aku	1,433	131	128	905	3,819	7,495	4,059	7,091	6,808	8,217	13,060	4,957
Akule	20,281	11,262	20,978	19,871	20,240	27,966	16,578	62,025	246,707	164,184	280,488	94,515
Aloalo (prawn)	234	25	13	111	40	35	50					
Ama-ama	74,596	68,194	79,996	84,471	75,928	62,618	90,943	113,759	123,303	155,606	171,076	143,326
Ananalo				26	2							
Apí	1			397								
Au	76	1	448	379		20	2					
Auau		24				8	40					
Auhu		1,410			49							
Awa	5,492	6,433	7,214	11,864	5,615	7,002	15,902	26,923	25,367	49,258	73,999	63,966
Awa-awa	1,236	668	2,265	1,740	2,973	2,059	9,702	19,551	13,461	44,888	62,188	56,849
Awa kalamoku	30	78	7	69	176	59	192	328	489	475	540	429
Awela			32	18	15	4	5	2	7	161	603	451
Aweoweo	5,619	1,624	2,685	1,009	998	1,154	4,073	16,103	107,926	33,844	17,219	27,242
China-fish	2	372	244	91	59	205			280	42	645	999
Ea	18	2	5	6	43	10						
Gold-fish	793	835	719	2,999	792	450	2,290	640	1,980	9,608	10,112	12,508
Hahalalu	11,741	3,978	2,561	1,596	216	16,834	5,359	14,992	151,875	26,179	118,198	37,970
Hapú'upú'u	119	125	408	139	182	233	254	413	464	344	759	554
Haúliúli	7	37								155	629	104
Haukeuke							80					
Hee (octopus)	2,398	854	706	430	403	591	2,177	4,547	4,090	3,164	3,854	5,597
Híhimánu	9		7	1	1	3	13	16	21	57	107	105
Hilu	52	66	368	60	30	28	40	3	39	164	323	443
Hinaléa	2,710	771	1,593	2,564	5,052	1,648	405	4,770	10,197	9,228	4,507	4,163
Honu (turtle)	9		9	14	24	11	8	4	82	24	35	38
Hou	4		1			10						
Húmuhúmu	546	93	169	756	517	194	259	593	845	1,104	1,428	1,578
Iheihe	8,816	8,600	2,169	2,437	419	1,578	3,258	3,335	3,331	8,057	35,830	8,252
Ina (sea urchin)	690	500					1,020		500	42	8,850	4,910
Kahála	74	46	144	210	295	314	120	331	351	112	102	125
Káku	185	141	173	286	140	252	272	487	655	732	1,997	2,023
Kála	2,062	823	687	556	515	1,094	1,336	463	2,452	2,568	2,744	3,168
Kálekále	16	3	1,350	13	55	94	14					
Kauleloa				1,525								
Káwakáwa	1,786	518	465	3,716	3,675	3,502	2,914	4,601	6,206	914	549	1,620
Kawelea	26	27	131	82	7	12	26	28	328	355	557	172
Kihikihi	10			15	3			18	15	32	688	344

Kóle	261	41	13	54	250	250	10	10	490	1,952	1,828	1,313
Kumu	1,516	1,298	2,246	2,745	3,248	1,879	2,173	2,544	8,202	32,217	59,020	36,020
Kupipi	14	10	46	5	3		32	35	321	1,482	2,011	1,011
Kupóupóu	759	212	94	190	286	68	47	1,300	2,290	2,888	1,815	1,446
Lae	477		552	465	481	361	192	353	306	1,111	1,714	4,563
Laeníhi	1,129	492	813	775	918	319	1,162	3,662	2,805	3,369	3,151	2,063
Lauhau	93	47	17	72	185	56	59	3	61	823	1,375	1,116
Lehe							1					
Lolohan	59	2	3			2						
Lupe	1		1	1		3						
Máhimáhi	44	109	40	92	190	120	298	617	1,542	234	757	274
Maii'i	2,608	519	237	391	686	347		225	1,014	5,115	4,224	1,498
Maiko							61	244	1,375	1,211	2,323	756
Maikoiko	167	104	64	238	294	27						
Maka'a	137	70	150	118	3	95	22	36	539	1,026	875	401
Malámaláma	5		12	8					60	356	777	387
Malolo	11	121	9	2	2,566	6,568	2,876	1,525	493	148	54	
Mamámo	1,121	169	63	58	114	166	442	195	1,817	6,650	1,404	1,887
Maníni	5,503	3,960	7,794	6,478	4,213	2,512	2,354	1,238	3,638	5,321	3,780	4,867
Mano	107	58	99	360	149	426	906	823	472	609	1,436	1,114
Mikiáwa			238	939	727	408	349	223	1,299	1,541	2,102	1,621
Miomio	6		2		27	12	5					
Moáno			7,827	10,682	8,049	6,192	5,254	7,793	17,529	12,852	8,715	4,531
Moelua				1	6	11	22					
Moi	8,495	2,155	6,633	3,903	6,056	4,818	6,333	4,265	11,136	119,220	186,031	75,294
Mu	15	15	2	42	134	6	8	28	30	202	457	129
Muhee (squid)	170	70	26	108	19	6	8	11			574	665
Naenae	96					4			68	239	600	233
Nenue	114	38	80	48	57	126	299	195	837	570	937	752
Nóhu	12	3	7	13	14	7	13	9	2	129	488	84
Nukumomi			8	5	5	31						
Nunu	602	121	183	132	218	150	316	174	515	2,175	3,739	3,144
Oama	11,378	3,050	6,818	2,281	414	140	500	117,342	116,087	201,569	374,840	182,120
Ohua	1,022	25										
O'ililepa	2		6	6					309	133	226	163
Oio	1,072	509	2,105	1,654	3,521	2,649	1,825	2,388	3,656	5,100	5,536	5,174
Olepe (clam)	300											
Omaka	402	317	500	739	1,443	738	830	672	1,317	1,730	3,311	3,090
Omilu	134	69	85	86	232	886	1,702	2,158	3,314	1,841	2,735	2,015
Ono	21	26	38	13	25	13	7	10	9	27	4	20
Oópu	838	6,528	499	10,533	949	442	2	202	1,490	1,968	2,736	2,327
Opakapaka	398	255	965	628	2,067	1,387	2,014	4,457	6,674	4,969	4,963	2,622
Opélu	13,583	624	3,341	10,183	14,446	6,695	11,176	36,650	77,935	96,269	40,593	31,864
Opule	442	129	115	459	68	95	553	140	2,010	1,880	1,763	1,707
Paki'i	6,609	2,807	4,543	397	2,874	1,317	2,721	1,440	2,623	9,289	5,584	4,816
Pakuikui	180	54	6	3					80	252	418	122
Palaheana		3	1									
Paláni	467	27	286	228	69	175	142	688	1,031	1,001	1,187	596
Panuhúnuhú	58	51	464	51	3,273	1,134				483	1,804	1,257
Páopáo				351	157							
Papai (crab)	16,256	6,191	8,427	8,820	12,412	8,721	24,536	23,077	28,690	31,904	15,553	15,629

Fish inspected in the Honolulu market in 1902, 1903, and 1904—Continued.

1904—Continued.

Species.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.
Papiopio	2,563	1,024	4,776	620	481	302	1,617	1,818	6,389	4,206	4,357	1,390
Pauú	3,577	1,199	1,313	1,184	1,584	1,485	2,955	6,363	22,858	144,501	139,923	61,737
Piao				380								
Póopá'a	1,575	521	319	967		399	642	1,424	4,459	3,435	2,966	1,558
Pooú	3	13	1	29	29	24				140	1,031	420
Puálu	2,426	1,386	1,330	1,694	1,278	1,080	2,247	2,924	7,307	16,842	9,000	3,873
Puhi	1,102	515	967	671	1,218	584	720	565	888	1,752	1,943	1,981
Puhiki'i	235			5	2,850	15,226	31,445	13,930	5,165	9,761	36,360	11,508
Puloa	14	3	4	5	11	30	81	7				
Sword-fish				3								
Uhu	382	81	104	189	557	270	77	136	778	586	624	556
Ukikiki	471	177	429	231	116	108	99	26	25	285	415	234
Uku	78	24	129	127	498	2,713	3,298	2,297	2,759	340	220	184
Ula (crawfish)	1,651	739	1,721	1,113	1,695	2,884	2,370	2,967	4,500	2,710	2,882	3,634
Uláe	5,342	3,141	8,434		5,865	1,699	1,530	3,630	7,761	38,598	18,099	6,759
Ulaapapapa (crawfish)	667	89	120	213	155	237	250	59	62	64	686	935
Ulaula	99	34	97	9,888	319	424	826	1,143	2,203	570	687	728
Ulua	205	59	261	202	2,072	2,688	697	528	742	873	922	199
Umaúmalei	125	25				30				65	595	232
Uóuoa	67		63	17		6						
Upapálu	1,045	357	580	771	390	686	897	4,284	10,518	5,801	8,209	6,039
U'u	13,902	3,037	2,209	3,416	4,072	2,760	12,325	27,023	207,847	72,003	39,943	25,782
Uwau			6		2							45
Uwiwi		4	6									
Wálu			1		2	1	1			23	6	32
Wana (sea urchin)	1,338				369	562	648	516	1,817	1,149	1,271	1,115
Weke	7,708	5,545	11,801	7,475	6,964	6,889	7,461	10,705	25,396	104,582	224,730	103,996
Fish condemned	1,920	1,013	1,565	1,388	2,369	2,680	2,598	7,746	9,546	18,027	10,357	7,925

THE WHOLESALE TRADE.

But two cities—Honolulu and Hilo—are engaged in the sale of fishery products by wholesale. The greater part of this trade is in canned goods and pickled salmon, large quantities of which are sold to the sugar plantations scattered over the islands. In 1903 none of the firms engaged exclusively in the sale of fishery products, but sold such in connection with other goods. A few of the sugar plantations purchased their supplies direct and are not included in the table below. A small quantity of fresh fish, brought from San Francisco in the cold-storage rooms of the regular steamers, is also sold in Honolulu.

Honolulu leads in this trade in every particular. The total investment in the business in 1903 was $520,350, a gain of $10,225 over 1900, when the investment amounted to $510,125. No effort was made to gather data on the quantity of products handled.

Table showing the wholesale fishery trade of the Hawaiian Islands in 1903.

	Honolulu.	Hilo.	Total.
Number of firms	9	4	13
Number of employees	71	23	94
Property	$219,850	$106,000	$325,850
Wages	32,300	15,000	47,300
Cash capital	112,500	34,700	147,200
Total	364,650	155,700	520,350

FISH PONDS.

The manner of construction and method of operation of fish ponds has been extensively discussed in the previous report. But little authentic data regarding their history have come to light since that time, although earnest efforts have been made to secure information from oral traditions and early printed chronicles. David Malo in his Hawaiian Antiquities[a] states that—

On the death of Kahoukapu the Kingdom [Hawaii] passed into the hands of Kauholanuimahu. After reigning for a few years Kauholaniumahu sailed over to Maui and made his residence at Honua-ula. He it was that constructed that fish pond at Keoneoio.

Dr. N. B. Emerson, the translator, in a note on page 267 of the work just quoted, ascribes the building of several fish ponds on the western side of Hawaii, at the coast of Hilea, at Honuapo, and Ninole, in the district of Kau, to Kiohala, who was King or Chief of Kau during the early years of the nineteenth century. He (the King) is said to have made himself exceedingly unpopular among his subjects by his exactions in the building of these ponds. The ponds are not in existence at present.

[a] Hawaiian Antiquities, by David Malo; translated from the Hawaiian by Dr. N. B. Emerson; p. 333. 8°. Honolulu, 1903.

According to Mr. A. F. Judd, in an article on "Rock carvings of Hawaii," published in Thrum's Annual for 1904—

Archæological investigations have brought to light several monuments of which the Hawaiians have always disclaimed the making. The fish pond in the land of Apua, at Kualoa on the island of Oahu, is a notable example, and others might be mentioned.

A typical example of fish ponds in embryo is to be observed in the neighborhood of Mana, on the island of Kauai. There are several hundred acres of overflowed land here belonging to the territory, which certain natives have leased for a nominal sum. Ditches have been dug in order that the sea water may enter, and in the ponds so improvised ama-ama are raised. It is probable that in the course of a few years the banks will be raised higher and made permanent, thus turning the swamp into a regular interior fish pond.

The Kanaha fish pond at Wailuku, on the island of Maui, is being much enlarged and improved this year (1904). There were formerly several ponds here, but the others have been filled in. Considerable trouble has been experienced with this fish pond owing to the lack of proper direct connection with salt water. A heavy freshet made an opening toward the sea about four years ago, but it was not deep enough to allow a sufficient quantity of sea water to enter, and since the rainwater forced the salt water out, the ama-ama were killed in large numbers. In 1903 this was especially noticeable, and in the latter part of the year many of the fish were given away or else sold very cheap, inasmuch as they would have died had they been allowed to remain in the pond. Awa, ahólehóle, gold-fish, and oópue are also found in this pond.

If the various schemes for the development of the bank fisheries off the south and east coasts of Molokai are successful there will probably be a considerable increase in the number of fish ponds used commercially in this section. Many ponds on this side of Molokai are not in use at the present time, owing to a lack of convenient markets. The new enterprises contemplate repairing and putting into operation some of these ponds, and using them either to raise ama-ama for the Honolulu markets, or as temporary storage places for the line-caught fish until the transporting vessels can carry them away

Considerable fishing is carried on in the numerous sugar-plantation reservoirs, notably in those on Maui, some of which are quite extensive. Carp and gold-fish are the principal species taken. This fishery has not yet attained commercial importance, nearly all of the fish taken being consumed by the workers on the various plantations, who catch them.

A number of the ponds are used as private preserves by their owners and do not appear in the commercial tables given herewith.

In the Lihue district, on Kauai, there are 7 of these private fish ponds.

Owners of fish ponds operated commercially rarely manage them directly, but lease them to others, usually Chinese. Nearly all of the Oahu ponds are controlled by a combination of Chinese, and are so operated as not to overstock the markets, thus keeping up the prices. This policy works to the disadvantage of the white population mainly, as they are the principal consumers of the ama-ama. Owing to the high prices received for this fish some of these ponds are very valuable, one located on Oahu being assessed by the Territory on a valuation of $25,000 (the lessee of this pond pays a yearly rental of $2,500), while two others in the immediate vicinity are assessed at $16,000 and $12,450, respectively. One on Koolau Bay, Oahu, is assessed at $12,000; another in Waipio, Oahu, at $6,400, and one in Kalihi, Oahu, at $4,000. Aside from those located on Oahu, fish ponds are not very valuable, largely owing to the lack of a steady and sufficient demand for ama-ama. If the fish could be marketed, the Molokai fish ponds would produce almost unlimited quantities of amaama.

The tables below show, by islands, the number and nationality of the persons employed, the number and value of the fish ponds and boats, the number, kind, and value of apparatus operated, the catch by species, and the catch by species and apparatus, together with the values of same, in the pond fisheries during 1903. The data in these tables appear also in the general statistical tables given elsewhere.

The island of Oahu leads in every particular, with 67 fish ponds valued at $154,900, 138 persons employed, and a total investment, including value of ponds and boats, of $156,990. Molokai is second, with 12 ponds valued at $4,050, 30 persons employed, and a total investment of $5,310. Kauai, Hawaii, Maui, and Lanai follow in the order enumerated. As compared with the data for 1900 there has been a decrease of 13 in the number of fish ponds operated, but in every other regard there have been slight increases. Since 1900 the fish pond on Lanai and the one at Kahului, Maui, have been repaired and are now in use. In that year there were no fish ponds operated commercially on these two islands.

Chinese predominate in the pond fisheries, 132 being so employed, to 55 Hawaiians and 6 Americans. In 1900 there were 147 Chinese, 43 Hawaiians, and 1 American, showing a decrease in 1903 of 15 Chinese and an increase of 12 Hawaiians and 5 Americans.

The total catch for Oahu is 578,292 pounds, valued at $93,568. As the total catch for all the islands was 672,953 pounds, valued at $111,321, the great preponderance of Oahu is manifest. Molokai is second, with 43,361 pounds, valued at $10,279, followed by Maui,

Kauai, Lanai, and Hawaii, in the order named. The latter island almost dropped out altogether, securing but 218 pounds of amaama, worth $54. Amaama is the leading species, 430,115 pounds, worth $87,706, having been marketed. Awa is second, with 224,321 pounds, which sold for $22,662. The other species—ahólehóle, carp, gold-fish, oópu, and opae—form but an insignificant part of the total catch.

As compared with 1900, the catch of ama-ama shows a decrease in weight of 55,416 pounds, and $31,496 in value. During the same period the catch of awa increased in quantity 30,150 pounds, and decreased in value $24,864. The ahólehóle catch increased from 200 pounds, valued at $30, in 1900, to 7,100 pounds, valued at $373, in 1903; the catch of carp decreased from 1,500 pounds, valued at $150, in 1900, to 400 pounds, valued at $32, in 1903; the gold-fish catch increased from 80 pounds, valued at $10, in 1900, to 6,267 pounds, valued at $351, in 1903 (most of this increase was on Maui); the oópu catch increased from 492 pounds, valued at $74, in 1900, to 4,600 pounds, valued at $174, in 1903, and the catch of opae decreased from 310 pounds, valued at $31, in 1900, to 150 pounds, valued at $23, in 1903. In 1900, 180 pounds of okúhekúhe, valued at $18, were taken, but none was sold in 1903.

The gill net is the leading form of apparatus in use, 322,240 pounds, valued at $54,610, having been taken thus. Dip and scoop nets are second, with 246,179 pounds, worth $40,397, and seines third, with 104,534 pounds, valued at $16,314. Gill nets alone were used on Hawaii and Lanai, seines alone on Maui, seines and gill nets on Kauai and Molokai, and all forms on Oahu.

Table showing by islands the number of persons employed, and the number and value of fish ponds, boats, and apparatus used in the pond fisheries of the Hawaiian Islands in 1903.

Items.	Hawaii.		Kauai.		Lanai.		Maui.	
	Number.	Value.	Number.	Value.	Number.	Value.	Number.	Value.
Fish ponds	3	$1,500	2	$1,900	1	$700	1	$2,500
Fishermen:								
Americans	2		4					
Chinese	8							
Hawaiians	2		3		2		4	
Total	12		7		2		4	
Boats	4	20	2	30				
Apparatus:								
Seines			1	130			1	30
Gill nets	5	30	1	10	2	16		
Shore and accessory property				10		10		50
Grand total		1,550		2,080		726		2,580

Items.	Molokai.		Oahu.		Total.	
	Number.	Value.	Number.	Value.	Number.	Value.
Fish ponds	12	$4,050	67	$154,900	86	$165,550
Fishermen:						
Americans					6	
Chinese	6		118		132	
Hawaiians	24		20		55	
Total	30		138		193	
Boats	14	690	27	690	47	1,430
Apparatus:						
Seines	2	80	5	160	9	400
Gill nets	24	240	55	1,100	87	1,396
Dip and scoop nets			52	140	52	140
Shore and accessory property		250				320
Grand total		5,310		156,990		169,236

Table showing by islands and species the yield of the pond fisheries of the Hawaiian Islands in 1903.

Species.	Hawaii.		Kauai.		Lanai.		Maui.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Ahólehóle							7,100	$373
Ama-ama	218	$54	9,000	$1,350	2,400	$600	20,306	4,061
Awa			700	70			3,176	614
Gold-fish							5,000	250
O-ópu							3,400	102
Total	218	54	9,700	1,420	2,400	600	38,982	5,400

Species.	Molokai.		Oahu.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Ahólehóle					7,100	$373
Ama-ama	40,061	$10,015	358,130	$71,626	430,115	87,706
Awa	3,300	264	217,145	21,714	224,321	22,662
Carp			400	32	400	32
Gold-fish			1,267	101	6,267	351
O-ópu			1,200	72	4,600	174
Opae			150	23	150	23
Total	43,361	10,279	578,292	93,568	672,953	111,321

Table showing by islands, apparatus, and species the yield of the pond fisheries of the Hawaiian Islands in 1903.

Apparatus and species.	Hawaii.		Kauai.		Lanai.		Maui.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines:								
Ahóle-hóle							7,100	$373
Ama-ama			6,000	$900			20,306	4,061
Awa			300	30			3,176	614
Gold-fish							5,000	250
O-opu							3,400	102
Total			6,300	930			38,982	5,400
Gill nets:								
Ama-ama	218	$54	3,000	450	2,400	$600		
Awa			400	40				
Total	218	54	3,400	490	2,400	600		
Grand total	218	54	9,700	1,420	2,400	600	38,982	5,400

Apparatus and species.	Molokai.		Oahu.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Seines.						
Ahóle-hóle					7,100	$373
Ama-ama	7,061	$1,765	30,000	$6,000	63,367	12,726
Awa			22,191	2,219	25,667	2,863
Gold-fish					5,000	250
O-opu					3,400	102
Total	7,061	1,765	52,191	8,219	104,534	16,314
Gill nets:						
Ama-ama	33,000	8,250	170,000	34,000	208,618	43,354
Awa	3,300	264	108,572	10,857	112,272	11,161
O-opu			1,200	72	1,200	72
Opæ			150	23	150	23
Total	36,300	8,514	279,922	44,952	322,240	54,610
Dip and scoop nets:						
Ama-ama			158,130	31,626	158,130	31,626
Awa			86,382	8,638	86,382	8,638
Carp			400	32	400	32
Gold-fish			1,267	101	1,267	101
Total			246,179	40,397	246,179	40,397
Grand total	43,361	10,279	578,292	93,568	672,953	111,321

THE FISHERIES CONSIDERED BY ISLANDS.

During the year 1903 commercial fishing was prosecuted from the islands of Hawaii, Kahoolawe, Kauai, Lanai, Maui, Molokai, Niihau, and Oahu. This list shows an addition since 1900, for no commercial fishing was done by the few inhabitants of Kahoolawe at that time. The fishermen from these islands also frequent some of the smaller islands of the group, which are uninhabited the greater part of the year. In 1904 Mr. Max Schlemmer, of Honolulu, who is in charge of the guano work on Laysan Island, made an offer to the territorial government to lease Necker and Gardiner islands for a term of twenty-one years at a yearly rental of $25. It is his intention to engage in fishing from these islands during the rainy season (the equivalent of winter in the temperate region), when the guano work is not being

carried on, and he expects to dry sharks' fins, and also dry and salt fishes and other aquatic products. The steady demand for sharks' fins among the Chinese resident in the islands is at present supplied by importation.

When the magnificent area of the deep-sea fishing banks off the Hawaiian Islands is considered, the marvel is that the skillful fishermen have not visited them more extensively. The chief reason undoubtedly has been that the native, having few wants, could easily satisfy them, either inside the reefs which partially girt the islands within a mile from shore, or at the detached reefs nearby. Quite a change in the methods of fishing followed the advent of the Japanese, who, coming from an island country where ocean fishing had been practiced from time immemorial, naturally embarked in the same industry here. A few years' experience showed that the best fishing grounds were on the reefs off the west and south coasts of Molokai, and now these grounds are regularly visited by a fleet of 40 to 50 Japanese sampans from Honolulu. It is the custom to make trips on Monday, returning on Friday or Saturday of each week. This can not be called a vessel fishery, however, because the largest of the sampans is not more than about 4 tons net.

Owing to the rapid increase of the population of Oahu (especially Honolulu, the capital) during the last decade, the demand for fishery products has grown at a tremendous rate. Unfortunately the supply from the local fisheries has not kept pace with this demand, and as a result prices have increased enormously on some of the choicer species. Owing to the high traffic rates exacted by the interisland steamer lines, it has not been practicable to secure supplies from the adjacent islands, and thus for years the extensive resources of Kauai, Maui, and Molokai have been only partially worked, owing to the absence of a convenient market, while Oahu was absolutely suffering for the lack of these products, although willing and anxious to pay a good price for them.

Several attempts have been made (all by white men) to improve this condition, but for various reasons all have heretofore met with failure. The last serious attempt was in 1898, when a company was formed in Honolulu. At considerable expense, this company had the gasoline schooner *Malolo* constructed and fitted out to engage in the business, and a station was established at Palaau district, on Molokai. The idea was to leave fishing crews at this station and use the vessel in carrying the catch to Honolulu. Owing to the unreliability of the various crews, however, the project had to be abandoned the same year it was inaugurated. In February and April, 1904, when the last investigation was made, various schemes for establishing vessel fisheries were being worked out. A company, of which Mr. Lee Gilbert, of Honolulu, is the head, was formed early in the year and a small

schooner of about 7 tons burden was fitted up with a gasoline engine. Wells were built into the fore and aft holds of the vessel, and in these the fish were to be kept alive until the selling port should be reached. A fishing station had been established at Kaunakakai, on Molokai, and seine, gill net, and line crews were to go from there to the fishing banks near by, returning to the station when necessary with their catch, which would be retained alive in a fish pond until the schooner arrived. The first trip to Honolulu was on March 26th, and it was the intention to make about two trips a week after the enterprise was well started.

The Inter-Island Live Fish and Cold Storage Company, of Honolulu, formed in the spring of 1904, in addition to its comprehensive market scheme for Honolulu, proposes to embark in the deep-sea fishing. The small steamer *Talula* has been fitted up with wells for carrying the fish alive, and her motive power has been changed from steam to gasoline. It is the intention to use her in collecting fish from the fishermen on the Koolau side of the island of Oahu, from Kahana to Waimanalo, and this will prove a great boon to the fisheries of that section, for heretofore it has been impossible to reach a market except by a difficult 15-mile wagon trip across the island to Honolulu. The company has also the gasoline schooner *Brothers*, which was built in 1902, and has fitted her with wells and for use in transporting live fish from fishing stations to be established on Molokai, Maui, Lanai, and Kahoolawe, to Honolulu, the expectation being to make about three trips a week. Both vessels will carry ice for refrigerating purposes, and such fish as can not be kept alive will be placed in cold storage until marketed.

Feeling against the Japanese fish dealers and fishermen has been developing rapidly during the last few years. It is charged that native fishermen have been driven out of business by Japanese control of the fish markets and the refusal of the monopolists to pay the natives as much as they pay their own countrymen for their catch. Also that by securing a practical monopoly on certain islands the Japanese have been able to raise the price to the consumer and otherwise to regulate the markets to his disadvantage. The dealers at Hilo and Lahaina are specifically charged with these offenses, while those of Honolulu are thought to be rapidly advancing toward the same methods. The present investigation would seem to sustain these charges. The Japanese dealers, and also the Japanese fishermen, have mutual associations at Hilo, Lahaina, and Honolulu, and possibly at other places, and all their business affairs are managed through the officers of these associations. As the Japanese form almost one-half of the total population of the islands and are the principal consumers of fish, every effort is made by these associations to secure and hold the trade of their own people, and it has been charged that they even resort to the ostracism of a countryman who buys from an outside dealer or fisherman when

it is possible to secure the same thing from his own people. The same condition of affairs is said to prevail in other lines of business, and a feeling of antagonism has developed on the part of those who have been injured by the alleged unfair competition. The Japanese fishermen deserve great credit for developing and extending the deep-sea fisheries, which the native fishermen had allowed almost to die out; but, on the other hand, they do an immense amount of damage by destructive, and, in many instances, illegal methods of fishing with fine-meshed nets.

One of the results of the rapidly increasing prejudice against the Japanese fishermen was the effort in the summer of 1902 to prevent them, as aliens, from landing their catch without paying a customs duty of 1 cent per pound. The collector of customs at Honolulu supported this contention, but on appeal the Treasury Department refused to sustain the collector's action.

The Russian-Japanese war had the effect of considerably lightening Japanese competition, as large numbers of the fishermen of that nationality returned to Japan to enter the army. Over 90 of them left Honolulu for this purpose on one steamer in March, 1904.

THE FISHERIES OF HAWAII.

This, the largest island of the group, is 90 miles in length from north to south and 74 miles from east to west, with an area of 4,015 square miles, which is nearly double that of all the other islands combined. Geologists claim that this island is the youngest of the group, as its internal fires are still unextinguished. It is made up principally of three enormous volcanoes, two of which are still active, and both of which are larger than any other active volcanoes in the world. Mauna Kea, which is 13,825 feet above the sea, is the highest point on the island, and Mauna Loa is 13,675 feet in height. Both are snow capped throughout the year. The coast line of the island is regular, sometimes precipitous, and is badly handicapped for commerce by the lack of good harbors. Hilo Bay, on the eastern or windward side, is a rather open harbor, partly protected from the ocean by a sunken coral reef. There is no other harbor on the eastern side, but merely landings, which can be made only in fairly clear weather. On the westward side are the small open bays of Kailua and Kealakekua, which are safe so long as the winds prevail from the westward, which they do for nine months of the year. On the northwest is the open harbor called Kawaihae Bay, which is safe about half of the year. The lack of good harbors has always been a serious drawback to the fisheries of this island, as the fishermen are compelled to concentrate at a few places and dare not go far out in their small boats lest they be caught in storms or be blown off the coast.

The island is divided into the districts of Hamakua, Hilo, Kau, Kohala, Kona, and Puna. Hawaii for its size is not very densely inhabited, its population at the last census being 46,843, and the only places of importance are Hilo on the east, Pahala on the south, Napoopoo and Kailua on the west, Kawaihae on the northwest, and Laupahoehoe on the north. While there are a number of railroads projected for this island, but three are now in operation—the Hilo Railroad, from Hilo to Puna Plantation, 23 miles, and a branch from Olaa, on this road, to Mountain View, on the way toward the volcano of Kilauea; the Kohala Railroad, from Mahukona to Niulii, a distance of 20 miles, and the plantation railroad from Pahala to Punaluu. The two first-named railroads have been of considerable help to the fisheries, as they have made feasible the shipping of fish to plantations away from the coast and to those on the coast where it is not practicable to conduct fisheries. The islands have been undergoing a period of depression during the last three years, but as soon as this passes away—as it seems to be doing at present—there will undoubtedly be a large increase in the railroad mileage of Hawaii, and this can not fail to benefit the fisheries. At present there are many fine fishing sections where, owing to the lack of shipping facilities, practically no fishing is being carried on, or else merely enough is done to supply the wants of the people in the immediate vicinity. The Territorial government, by opening up new roads and repairing the old ones, is also incidentally helping the fisheries.

During the year 1903, 200 pounds of loli (bêche-de-mer) was gathered and sold to Chinese at Hilo, who prepared and shipped the product to San Francisco. In the curing process the loli after being split in half and having the entrails removed, are put in hot water in order to remove the slime, etc., and then placed in strong brine for twenty-four hours. On being removed from the brine they are dried in the sun, after which they are ready to ship. This is a new industry and gives promise of a considerable development in the near future, as the loli is quite abundant in the waters surrounding the island.

Another industry which gives promise of becoming quite important is the raising of frogs for market. In October, 1899, a shipment of 6 dozen frogs from Contra Costa County, Cal., was landed at Hilo and planted in favorable places around the city. Frogs soon became abundant, and in 1900 a few were taken for market, while in 1901 some were shipped to Honolulu. In the latter part of 1903 Lucas & Guard, of Hilo, leased the old Wailama canal, which formerly connected several of the fish ponds with the bay, but which had been cut off from the latter by the extension of the Hilo Railroad. This canal, or pond now, is about 200 feet in length by about 70 feet wide. It has been fenced around and a wire screen placed at the narrow opening

where the canal passes under the street, so that the frogs will be unable to get out and their enemies can not enter. At one side of the pond, where the water is shallow, a large section has been fenced off from the rest by a fine-meshed wire screen and divided into two compartments, in which are placed the eggs and the young tadpoles. In the larger section the young and full-grown frogs are allowed to roam at will. The pond contains many water hyacinths and pond lilies, which are quite necessary to the comfort and safety of the batrachians, screening them from the sun and from their chief enemies, the birds. The frogs are generally secured from the rivers and ponds near by, where they are caught by small boys armed with hook and line or scoop net. A uniform price of $1 per dozen is paid for these without regard to size. No attempt is made to feed them, and as they grow rapidly it is evident that natural food is quite abundant in the inclosure.

Only the medium-sized frogs are now shipped to market, the large ones being retained for breeding purposes. Shortly before shipment the frogs are removed from the pond to the wholesale market at Waiakea, near by, where they are placed in a tank built specially for the purpose. This tank, which is raised on supports, is about 15 feet long, about 5 feet wide, and about 4 feet deep, with the top slanting inward slightly in order to prevent the frogs from climbing up. The tank is divided by wire screens into four compartments, two of which are surrounded by a screen superimposed on the top of the tank, and reaching up about 6 feet, and the more active frogs are put into these compartments. Fresh water is supplied daily by means of a small electric pump. Although not introduced until 1899, the frogs have already attained a large size. Of three of the largest ones in the shipping tank on one occasion, two weighed 2 pounds each and the other 1¼ pounds. Thirty-six of all sizes, gathered from the tank and weighed together, averaged 5 ounces each.

Most of the frogs at present are shipped to the San Francisco markets via the regular line plying between Hilo and that port. They are sent in long, water-tight boxes with several inches of water at the bottom, this being changed every day during the eight to ten days required for the journey. The percentage of loss in transit is very small. A few frogs are also shipped via the interisland steamers to Honolulu and other towns, and all indications predict a rapid extension of the industry, as the animals are being introduced on the other islands, and efforts are being made to propagate them.

In 1900 Hawaiians predominated in the fisheries of this island, numbering 405 persons. At that time there were but 134 Japanese engaged in fishing. In 1903 this condition of affairs was reversed, and there were then 406 Japanese to 391 Hawaiians, an increase of

272 Japanese and a decrease of 14 Hawaiians. The other nationalties show small increases, but they occupy an insignificant proportion of the total, which, in 1903, was 827, as compared with 549 in 1900, a gain of 278.

The total investment in boats, apparatus, fish ponds, and shore and accessory property in 1903 was $37,912. As compared with 1900 there is a very material gain in the number of boats owned and the number of seines, bag nets, and cast nets operated, while the value of the lines used is more than doubled. There is a very material decrease, however, in the number of gill nets in use, and one less fish pond was operated.

The total catch was 1,404,794 pounds, valued at $101,149. The line fisheries furnished more than four-fifths of this. Gill nets, seines, cast nets, spears, dip nets, hands, baskets, bag nets, and snares follow in the order named. The akule is the principal species taken in the Hawaii fisheries, over one-third of the total catch being composed of this species alone. The other important species are aku, ulua, moáno, káwakáwa, oío, opélu, and puhi.

The following tables show the extent of the fisheries in 1903:

Table showing by nationalities the persons engaged in the fisheries of Hawaii in 1903.

	In shore fisheries.	Shoresmen.	Total.
Americans	6	4	10
Chinese	12	4	16
Hawaiian men	312	2	314
Hawaiian women	77		77
Japanese	383	23	406
Portuguese	4		4
Total	794	33	827

Table showing the boats, apparatus, fish ponds, and property used in the fisheries of Hawaii in 1903.

Item.	Number.	Value.	Item.	Number.	Value.
Boats	260	$18,970	Apparatus—(continued):		
Apparatus:			Baskets (opai)	42	$21
Seines	a22	4,850	Spears	95	95
Gill nets	b43	1,460	Snares	4	3
Bag nets	22	715	Fish ponds	3	1,500
Cast nets	124	620	Shore and accessory property		8,342
Dip nets	22	110			
Lines		1,226	Total		37,912

a 1,153 yards. b 2,198 yards.

Table showing by apparatus and species the yield of the fisheries of Hawaii in 1903.

Species.	Seines.		Gill nets.		Bag nets.		Cast nets.		Dip nets.		Lines.		Baskets.		Spears.		Snares.		Hands.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
A'alaihi	200	$2					15,411	$154													15,611	$156
A'awa	2,169	289	1,086	$144																	3,255	433
Ahaáha											1,371	$69									1,371	69
Ahi							5,775	289			52,430	2,097									58,205	2,386
Ahólehóle	3,800	333									100	9									3,900	342
Aku, fresh											118,170	4,727									118,170	4,727
Aku, dried											48,000	1,920									48,000	1,920
Akule, fresh	19,172	863	33,144	1,492			23,080	1,154			406,973	20,349									482,369	23,858
Akule, dried											20,500	1,105									20,500	1,105
Ama-ama	2,034	407	218	54			1,356	271													3,608	732
Auau			1,068	22																	1,068	22
Au'ku															1,000	$40					1,000	40
Awa	756	84																			756	84
Awa-awa	250	25	66	6																	316	31
Awela											175	18									175	18
Aweoweo			1,879	120																	1,879	120
Hapú'upú'u											781	127									781	127
Haúliúli, fresh											11,600	928									11,600	928
Haúliúli, dried											9,100	455									9,100	455
Híhimánu											60	6			1,500	120					1,560	126
Hilu			88	5																	88	5
Hínaléa											889	45									889	45
Húmuhúmu			328	8							9,010	270									9,338	278
Iheihe	5,100	765	204	33																	5,304	798
I'iáo	900	14																			900	14
Kahála	100	5									23,940	1,197									24,040	1,202
Káku			36	3																	36	3
Kála	33	3	300	25																	333	28
Kálekále											13,316	1,332									13,316	1,332
Káwakáwa	1,300	195									54,737	2,737									56,037	2,932
Kawelea	1,400	224	4,006	668																	5,406	892
Kóle			84	17							125	3									209	20
Kumu	1,293	171	990	132							300	36			450	60					3,033	399
Kupipi							67	6													67	6
Laeníhi	100	1	193	1							250	2									543	4
Lae	150	9	1,731	104							2,339	140									4,220	253
Lauhau							1,785	89													1,785	89
Lupe											5,350	321									5,350	321
Máhimáhi											18,599	1,488									18,599	1,488
Maii'i			32	4																	32	4

Table showing by apparatus and species the yield of the fisheries of Hawaii in 1903—Continued.

Species.	Seines.		Gill nets.		Bag nets.		Cast nets.		Dip nets.		Lines.		Baskets.		Spears.		Snares.		Hands.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Maikoiko			68	$5							75	$6									143	$11
Malolo	600	$150									18	5									618	155
Manini			1,694	138							2,489	199									4,183	337
Mano	778	17									4,219	94									4,997	111
Mikiáwa	25	3																			25	3
Moáno	333	40									65,947	7,914									66,280	7,954
Moi			6,779	1,085																	6,779	1,085
Mu			24	2																	24	2
Nehu	200	2					830	$14													1,030	16
Nenue			496	79																	496	79
Nóhu											1,644	164									1,644	164
Nunu	200	3									45	6									245	9
Oio			500	80							47,679	7,629									48,179	7,709
Omakaha	545	163			833	$250															1,378	413
Ono											13,968	698									13,968	698
Oópuhúe													285	$57							285	57
Oópukái	1,015	51									39	2									1,054	53
Opélu, fresh	14,288	2,572	459	83					16,020	$2,884	3,025	545									33,792	6,084
Opélu, dried	5,000	200																			5,000	200
Opule											349	35									349	35
Páka											3,008	250									3,008	250
Paki'i							8,590	859													8,590	859
Paláni	100	5	225	9							185	7									510	21
Panuhúnuhú											71	18									71	18
Pauú	7	2																			7	2
Póopá'a											697	56									697	56
Pooú			951	159																	951	159
Puálu											1,122	56									1,122	56
Puhi											23,931	1,914			2,566	$205					26,497	2,119
Uhu			1,653	138																	1,653	138
Uku											3,475	695									3,475	695
Uláe			30	2																	30	2
Ulaula			7,000	1,750							10,308	3,092									17,308	4,842
Ulua	290	30	9,364	925							141,397	11,322									151,051	12,277
Umaumalei			42	12																	42	19
Uouóa			588	59																	588	52
Upapálu											1,196	179									1,196	179
U'u			713	71							19,231	962									19,944	1,033
Uwau			53	11																	53	11
Weke	400	24	4,062	271																	4,462	295

Frogs											2,400	500									2,400	500
Hee, fresh											3,950	593			9,549	1,411			1,337	$191	14,836	2,195
Hee, dried											2,950	374			4,050	540					7,000	914
Honu															475	24					475	24
Leho																			50	3	50	3
Limu																			1,425	156	1,425	156
Loli																			200	20	200	20
Opae													1,500	180					73	9	1,573	189
Opihi																			587	66	587	66
Papai	1,268	76																	2,703	162	3,971	238
Ula			150	25							2,000	200			1,350	140	700	$68	2,126	213	6,326	646
Wana																			1,458	146	1,458	146
Wi																			20	2	20	2
Total	63,806	6,728	80,304	7,742	833	250	56,894	2,836	16,020	2,884	1,153,533	76,896	1,785	237	20,940	2,540	700	68	9,979	968	1,404,794	101,149

THE FISHERIES OF KAHOOLAWE.

This island, which is 6 miles west of Maui, has an area of 69 square miles and, like all of the others, is quite mountainous, its highest elevation being 1,130 feet above the sea. It is devoted to sheep raising. In 1900 the sheep herders employed on the island possessed a seine, which they used in catching a supply of fish for their own consumption, but as they had no surplus none were sold. During the year 1903 five Hawaiians and four Japanese operated two seines and caught 27,100 pounds of fish, which they sold at Maui towns for $1,456.

The following tables show the extent of the fisheries in 1903:

Table showing the fishermen engaged, and the boats, apparatus, and shore property used in the fisheries of Kahoolawe in 1903.

Item.	Number.	Value.
Fishermen:		
Hawaiians	5	
Japanese	4	
Total	9	
Boats	3	$225
Apparatus:		
Seines	a 2	250
Shore and accessory property		150
Total		625

a 670 yards.

Table showing by apparatus and species the yield of the fisheries of Kahoolawe in 1903.

Species.	Seines. Pounds.	Seines. Value.	Species.	Seines. Pounds.	Seines. Value.
Akule	18,000	$1,080	Mu	200	$28
Kumu	500	50	Puálu	100	5
Laenihi	2,000	100	Total	27,100	1,456
Moáno	200	10			
Moi	6,100	183			

In January, 1904, Mr. Christian Conradt leased the island, and expects to devote a considerable part of his energy and capital to the development of its fisheries. It is a favorite resort of many schools of choice fishes, and only the lack of good harbors and the refusal of the former lessees to permit outside fishermen on the island, or even to fish in the adjacent waters previous to the abrogation of the fishery rights in the islands, had prevented its development into an excellent fishing station. The present lessee will operate several seines on the beach and will have a net pen anchored in the little bay near the settlement, in which the fish will be retained until it is convenient to send them to Malaaea Bay, on Maui, on a gasoline launch. Owing to the number of sharks in the waters surrounding the island, it has been found necessary to have a net constantly stretched across the mouth of the bay to keep them away from the pen.

THE FISHERIES OF KAUAI.

This island, which is the most northerly of the group, is about 63 miles from Oahu, the nearest large island, and has a length of 25 miles, a breadth of 22 miles, and an area of 547 square miles. It is mountainous, like the rest of the group, but, owing to its greater age, the lava which was vomited forth by its long extinct volcanoes has nearly all decomposed, and as a result the soil is very much more fertile than that of the other islands. It is supplied with numerous streams and cascades and has some superb valleys; it has been well named the "Garden Isle." The chief drawback is its lack of good harbors, all of the small bays around the island being wind-swept at some season of the year.

The island is divided into five districts: Hanalei, Kawaihu, Lihue, Koloa, and Waimea. The principal towns are Waimea, Lihue, and Hanalei, and at the time of the census of 1900 the population of the island was 20,562.

Although in the waters adjacent to this island fish are very abundant, only spasmodic efforts are made to catch them. The greater part of the fishing is carried on by native huis, or companies, which possess probably the best equipment to be found in the whole group, but lack the inclination to use it persistently. But few of the nets are operated more than once or twice a week, and if an exceptional catch is made the native fishermen will not go out again until they have spent all of its proceeds. This is especially true of that part of the coast lying between Nawiliwili and Hanalei. As a result there are gluts of fish for a few days near the fishery and then a period of scarcity, which varies in duration according to the inclination of the natives. The few seines owned by Chinese are operated consistently and well, and the Japanese, who devote their attention to the line fisheries principally, are steady workers. The inhabitants in the easily accessible portions of the interior of the island are served with fresh fish by a few peddlers who buy up the surplus catch of the fisheries and carry it around in small carts and wagons drawn by horses. Many of the inhabitants, however, find it impossible to secure fresh fish at any price during the greater part of the year and are forced to depend upon salted and canned products.

The products of the river fisheries of the island, which are insignificant, have been included with the shore fisheries. A little fishing was carried on in the Hanapepe, Hoale, Waiaula, and Waimea rivers, with cast and dip nets, traps and opae baskets. Ama-ama, oópu, and opae were the only species taken.

Carp are quite common in the irrigation ditches throughout the island, and with gold-fish and a Chinese species of cat-fish are quite numerous in the upper reaches of the River Haole and in private fish ponds in the Lihue district. But few are taken for market, however.

Frogs were introduced on this island about four years ago, and soon became fairly common in certain districts. In 1903 Mr. Francis Gay placed some near Makaweli, and Knudsen Brothers, of Kekaha, introduced them in their neighborhood early in 1904.

The pond fisheries are included in the tables below, but more detailed information in regard to them is shown elsewhere in this report.

In 1903 there were 314 persons engaged in the fisheries on Kauai, a gain of 107 over 1900. This gain is almost entirely among the natives, who increased from 120 to 237. There are not many Japanese employed as yet. The number of Chinese fell from 34 in 1900 to 19 in 1903.

The total investment in the fisheries is $15,101. Since 1900 the number of seines has increased from 1 to 21, and gill nets from 14 to 35. Bag nets and dip nets decreased in number, but the number of fish ponds decreased from 6 to 2. This does not mean that these fish ponds are abandoned, but that their owners obtained from them merely enough for their own wants, and consequently had no fish to sell, so that the ponds are removed from the commercial class for the time being.

The total catch was 377,946 pounds, valued at $34,738, a decrease as compared with 1900. More than one-half of the catch was made with seines.

The following tables show the condition of the Kauai fisheries in 1903:

Table showing by nationalities the number of persons engaged in the fisheries of Kauai in 1903.

	In shore fisheries.
Americans	4
Chinese	19
Hawaiian men	223
Hawaiian women	14
Japanese	54
Total	314

Table showing the boats, apparatus, fish ponds, and property used in the fisheries of Kauai in 1903.

Item.	Number.	Value.	Item.	Number.	Value.
Boats	71	$4,880	Apparatus—Continued:		
Apparatus:			Baskets (opae)	16	$12
Seines	a 21	5,585	Traps	13	185
Gill nets	b 35	324	Spears	4	8
Bag nets	2	300	Fish ponds	2	1,900
Cast nets	20	200	Shore and accessory property		1,550
Dip nets	12	24			
Lines		133	Total		15,101

a 4,133 yards. b 1,009 yards.

Table showing by apparatus and species the yield of the fisheries of Kauai in 1903.

Species.	Seines. Lbs.	Seines. Value.	Gill nets. Lbs.	Gill nets. Value.	Bag nets. Lbs.	Bag nets. Value.	Cast nets. Lbs.	Cast nets. Value.	Dip nets. Lbs.	Dip nets. Value.	Lines. Lbs.	Lines. Value.	Baskets. Lbs.	Baskets. Value.	Traps. Lbs.	Traps. Value.	Spears. Lbs.	Spears. Value.	Hands. Lbs.	Hands. Value.	Total. Lbs.	Total. Value.
Ahi	2,750	$175																			2,750	$175
Ahólehóle	333	50	680	$54																	1,013	104
Aku											11,420	$1,144									11,420	1,144
Akule	72,366	4,137			23,200	$1,610					7,550	735									103,116	6,482
Ama-ama	89,858	8,255	10,100	1,048	9,000	780	14,100	$1,899													123,058	11,982
Awa	5,200	358	860	77							300	29									6,360	464
Awa-awa	2,390	207																			2,390	207
Carp							3,100	186													3,100	186
Ehu											1,200	116									1,200	116
Iheihe (Puili)									7,100	$1,775											7,100	1,775
Hihimánu	210	15			50	4															260	19
Húinuhúinu											1,035	100									1,035	100
Káku			1,050	79																	1,050	79
Kála	1,706	152																			1,706	152
Káwakáwa	3,580	256			100	8					1,575	155									5,255	419
Kumu											2,900	280									2,900	280
Mano	440	22			200	16															640	38
Mikiáwa	90	7			80	6															170	13
Moi	14,226	1,308	5,200	888	200	16	2,700	540													22,326	2,752
Nenue	2,225	190																			2,225	190
Oio	12,870	1,120			1,300	128					11,400	1,124									25,570	2,372
Oópu													3,050	$520	7,300	$730			900	$180	11,250	1,430
Opakapaka											600	140									600	140
Opélu	650	44			200	16															850	60
Puhi											625	55									625	55
Úku											1,400	140									1,400	140
Ulaula											8,100	790									8,100	790
Ulua	6,487	550	490	39	2,000	200					14,500	1,408									23,477	2,197
Weke											440	44									440	44
Hee, fresh																	600	$75			600	75
Hee, dried																	1,200	150			1,200	150
Honu	250	11			100	5															350	16
Linu																			1,710	212	1,710	212
Opae													1,100	100					400	40	1,500	140
Opihi																			600	120	600	120
Wi																			600	120	600	120
Total	215,631	16,857	18,380	2,185	36,430	2,789	19,900	2,625	7,100	1,775	63,045	6,260	4,150	620	7,300	730	1,800	225	4,210	672	377,946	34,738

THE FISHERIES OF LANAI.

This island lies about 9 miles west of Maui, is 21 miles in length and 8 in breadth, and has an area of 139 square miles. At the southeastern end there is a mountain 3,000 feet high. The island is the property of one person, Mr. Charles Gay, and its principal industry is sheep raising. According to the census of 1900 it had a population of 619. Schools of fish congregate around its shores, and it is the favorite resort of the fishermen from Lahaina and the eastern portion of Molokai. Since 1900 there has been a decrease of 24 in the number of persons engaged in the fisheries, and of 81,959 pounds in quantity and $18,884 in value of catch. This is largely due to Japanese competition, which has driven the native fishermen out of business. Seines and lines were used exclusively in the shore and sea fisheries, the two gill nets shown being used in the one fish pond operated.

The following tables show the extent of the industry in 1903:

Table showing the fishermen engaged, and the boats, apparatus, and shore property used in the fisheries of Lanai in 1903.

Item.	Number.	Value.
Fishermen:		
Hawaiians	22	
Boats	20	$2,500
Apparatus:		
Seines	[a]17	350
Gill nets	[b]2	16
Lines		50
Fish ponds	1	700
Shore and accessory property		90
Total		3,706

[a] 650 yards. [b] 60 yards.

Table showing by apparatus and species the yield of fisheries of Lanai in 1903.

Species.	Seines.		Gill nets.		Lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'awa					300	$108	300	$108
Ahaáha					40	4	40	4
Ahólehóle					50	5	50	5
Aku					1,366	55	1,366	55
Akule	41,000	$1,128			483	13	41,483	1,141
Ama-ama	7,675	1,012	2,400	$600			10,075	1,612
Awa					500	40	500	40
Awa-awa					212	25	212	25
Aweoweo					90	10	90	10
Hapú'upú'u					1,250	167	1,250	167
Haúliúli					220	22	220	22
Híhimánu					120	6	120	6
Hilu	100	8					100	8
Húmuhúmu					2,178	109	2,178	109
Iheíhe	55	13					55	13
I'iáo	3,750	60					3,750	60
Kahála					6,000	405	6,000	405
Káku					40	2	40	2
Kála	190	15					190	15
Kálekále	400	40			25	3	425	43
Kananio					100	5	100	5
Káwakáwa					4,100	523	4,100	523

Table showing by apparatus and species the yield of fisheries of Lanai in 1903—Cont'd.

Species.	Seines.		Gill nets.		Lines.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Kumu	300	$49					300	$49
Kupóupóu					50	$13	50	13
Laeníhi	5,000	500					5,000	500
Lae	100	3					100	3
Máhimáhi					1,476	81	1,476	81
Maii'i	20	2					20	2
Malámalámà					40	2	40	2
Mano					120	12	120	12
Moáno	1,200	288			888	213	2,088	501
Moelua					164	16	164	16
Moi	5,600	660					5,600	660
Mu	125	30					125	30
Nehu	8,750	158					8,750	158
Oio					420	32	420	32
Ono					2,700	1,080	2,700	1,080
Opakapaka					2,908	291	2,908	291
Opule	80	40					80	40
Panuhúnuhú					144	22	144	22
Páopáo	70	21					70	21
Piha	2,500	40					2,500	40
Póopá'a					242	24	242	24
Pooú					182	22	182	22
Puálu	110	14			60	8	170	22
Puhi					300	45	300	45
Ukikiki					82	8	82	8
Uku					7,000	1,505	7,000	1,505
Uláe					80	8	80	8
Ulaula					590	295	590	295
Ulua					15,786	1,054	15,786	1,054
Umaúmaleí	190	38					190	38
Upapálu					20	2	20	2
U'u					258	23	258	23
Wálu					300	45	300	45
Muhce	30	15			40	20	70	35
Papai					100	12	100	12
Total	77,245	4,134	2,400	$600	51,024	6,335	130,669	11,069

THE FISHERIES OF MAUI.

This island, which is the second of the group in size, lies about midway between Hawaii and Molokai, and is 46 miles in length and 30 miles in width, with an area of 728 square miles. It is composed of two mountains—Haleakala to the northwest, with a height of 10,032 feet above sea level, and Eaka to the southeast, rising 5,820 feet in height. These two mountains are connected by a sandy isthmus 7 or 8 miles long by 6 miles across, which lies at such a slight elevation above the sea that the depression of a few feet would make Maui into two islands. There are no good harbors about the island. Kahului Bay and Maalaea Bay, on the north and south, respectively, of the neck of land joining the two parts of the island, are very open and wind-swept during the greater part of the year, while Lahaina is nothing but an open roadstead, though fairly safe as long as the wind blows from the westward, which it does nine months of the year. Kapueokahi Bay, at the western end, and Napili Bay, at the eastern end of the island, are small, open bays, not much used except for loading sugar. As a result of these conditions fishing on the island is largely confined to the vicinity of the two larger harbors.

The island is divided into five districts—Hana, Honuaula, Kaupo, Lahaina, and Wailuku. The population at the last census was 24,797. Lahaina, Wailuku, Kahului, Sprecklesville, and Hana are the principal towns and settlements. A railroad extends from Wailuku to Kahului, Sprecklesville, and Keia, and is used considerably in distributing fish landed at Kahului. Nine-tenths of the fishermen make their headquarters at either Lahaina or Kahului. At the latter place is located the Kahului fishery, owned by the Hawaiian Commercial and Sugar Company, which is one of the most important enterprises in the islands. The company leases the fishery for a rental of one-half the gross proceeds and furnishes everything but the labor required to operate it.

During the year covered by this investigation the Japanese line fishermen at Kahului were very successful. At this place Chinese buy the nehu and other very small fish taken in the nets, dry them in the sun on bags laid on the grass, and then peddle them throughout the surrounding country for about 25 cents per pound.

Owing to the large number of Japanese employed on the numerous sugar plantations of the island, there is a large demand for fresh fish, and this is supplied mainly by Japanese peddlers with horses and carts, who make periodical trips to the plantations from Lahaina and Kahului. The surplus from the fisheries of Kahoolawe, Lanai, and the western end of Molokai is marketed at either Lahaina or Kahului, and helps to supply the constantly increasing demands of the Maui fish consumers. There are at present no fish inspectors upon Maui, and as a result considerable old and tainted fish is sold. This is especially true at Lahaina.

One of the most interesting features of the fisheries of Lahaina disappeared in October, 1903, when the South Sea, or Gilbert, Islanders, who had a settlement in the upper part of the town, returned to their old home. These people had introduced and practiced a number of interesting and profitable methods of fishing, particularly that with baskets. They also did most of the spearing.

The Japanese fishermen at Lahaina and Kahului during the last two years have very much surprised the natives by catching akule with hook and line. Heretofore the natives used seines exclusively in this fishery, as they supposed it was impossible to catch akule on a hook. The Japanese are very secretive as to how they accomplish it, but the natives claim that the following method is pursued: The line has a chicken quill attached just above the hook, the lower part of the quill being broken out on all sides. The fishing is done at night, and the fishermen carry a flaring torch in the bow of the boat, to attract the fish. The line is dropped into the water and worked up and down, and it is supposed that the fish, seeing the reflection of the light on the

quill and thinking it a minnow, snap at it, and are thus caught on the hook. It is more probable, however, that when the fish have come up close to the light, the fishermen jerk the line up suddenly, catching the hook in the body of the fish, which may then be drawn quickly and easily into the boat.

Mr. Henry Williams, of Lahaina, purchased a gasoline launch in 1902 for use in line fishing, and also to cruise around among the fishing boats and buy their catches whenever possible, running into Lahaina to sell to the dealers at the markets. The boat was laid up about the middle of 1903 and has not been used in the fisheries since.

The irrigation dams and ditches on Maui contain many carp and gold-fish, but no commercial use is made of them as yet, although large numbers are taken for home use by the Japanese and Chinese employed on the plantations.

The streams of the island are few in number and are practically nothing but mountain rills. They contain gold-fish, oópu, uwau, and opae in large numbers, and while many of these are caught by the natives for home use, but few are sold.

Frogs are said to be quite numerous in the pools and taro patches of Wailuku and Makawao, having been introduced a few years ago, but no commercial use is made of them as yet.

The fisheries of the island have not varied much during the last three years. In 1900 there were 297 persons employed, while in 1903 there were 279, a decrease of 18. The principal change in the fishermen has been with the Japanese, who increased from 37 in 1900 to 80 in 1903, while during the same period the number of Hawaiians engaged decreased 63. There were 25 Gilbert Islanders (South Sea Islanders) engaged in the fisheries, but they left the islands in October, 1903.

The total investment in the fisheries was $18,511, an increase of $3,340 over 1900. This increase is accounted for largely by the cleaning out and putting to use of an old fish pond at Kahului.

The total yield of the fisheries was 1,212,445 pounds, which sold for $120,267. Lines are the most successful form of apparatus in use. Bag nets are second, and these are followed in the order named by seines, gill nets, baskets, spears, cast nets, and scoop and dip nets. Quite a number of native women and children also engaged in fishing with the hands alone. The principal species taken in the fisheries are akule, opélu, nehu, ulua, oío, aku, amaama, káwakáwa, and úku.

The following tables show the extent of the fisheries in 1903:

Table showing by nationalities the number of persons engaged in the fisheries of Maui in 1903.

	In shore fisheries.
Chinese	6
Hawaiian men	114
Hawaiian women	54
Japanese	80
South Sea Islanders	25
Total	279

Table showing the boats, apparatus, fish ponds, and property used in the fisheries of Maui in 1903.

Item.	Number.	Value.	Item.	Number.	Value.
Boats	94	$8,985	Apparatus—Continued:		
Apparatus:			Baskets (fish)	38	$380
Seines	a 30	1,290	Baskets (opai)	15	15
Gill nets	b 30	750	Spears	31	41
Bag nets	49	1,865	Fish ponds	1	2,500
Cast nets	25	200	Shore and accessory property		2,158
Scoop and dip nets	25	55			
Lines		272	Total		18,511

a 1,610 yards. b 1,500 yards.

Table showing by apparatus and species the yield of the fisheries of Maui in 1903.

Species.	Haul seines.		Gill nets.		Bag nets.		Cast nets.		Scoop and dip nets.		Lines.		Baskets.		Spears.		Hands.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
A'alaihi					1,600	$128	1,746	$133											3,346	$261
A'awa											2,196	$659							2,196	659
Áha					1,180	59					100	5							1,280	64
Ahi											30	2							30	2
Ahólehóle	7,100	$124	600	$10							2,750	413							10,450	547
Aku											57,978	2,174							57,978	2,174
Akule	171,334	3,400									96,548	2,600							267,882	6,000
Ama-ama	32,972	6,919	7,036	938															40,008	7,857
Auan			272	20															272	20
Au'ku															200	$24			200	24
Awa	3,176	211	1,000	333							4,712	1,178							8,888	1,722
Awa-awa	1,000	300	400	66							536	64							1,936	430
Aweoweo			7,500	500							2,949	304							10,449	804
Gold-fish	5,000	250							443	$22									5,443	272
Haúliúli											1,335	168							1,335	168
Hapú'upú'u											5,372	716							5,372	716
Híhimánu											835	209							835	209
Hilu	63	5			2,180	145							3,600	$240					5,843	390
Hinaléa					3,360	168					1,747	87	5,300	336					10,407	591
Húmuhúmu											9,636	482							9,636	482
Iheíhe	528	127									1,945	467							2,473	594
I'i					600	60													600	60
I'iáo	6,250	100			500	7													6,750	107
Kahála	713	44									19,276	301							19,989	345
Káku									2,900	363									2,900	363
Kála	120	10	800	11	2,246	186							300	20					3,466	227
Kálekále	150	15									73	2							223	17
Kananio											212	21							212	21
Káwakáwa	8,200	2,050									24,268	3,034							32,468	5,084
Kawelea	489	150																	489	150
Kóle					28,000	224													28,000	224
Kumu	6,650	1,060			129	16													6,779	1,076
Kupipi							78	1											78	1
Kupóupóu					875	219					652	163							1,527	382
Laeníhi	4,797	108			2,100	110													6,897	218
Lae	6,132	388	5,000	500															11,132	888
Laipála					1,730	311													1,730	311
Lauhau					300	60	424	25											724	85
Máhimáhi											10,678	508							10,678	508
Maii'i					1,565	188													1,565	188
Malámalláma											12	1							12	1
Mamámo					175	8													175	8

Table showing by apparatus and species the yield of the fisheries of Maui in 1903—Continued.

Species.	Haul seines.		Gill nets.		Bag nets.		Cast nets.		Scoop and dip nets.		Lines.		Baskets.		Spears.		Hands.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Manini			600	$12	1,480	$118							150	$9					2,230	$139
Mano	800	$24									25	$5			10	$1			865	30
Maumau					400	72													400	72
Mikiáwa	300	30																	300	30
Moáno	853	14			12,600	1,890					9,959	1,574							23,412	3,478
Moelua											592	148							592	148
Moi	4,282	514	2,900	290	1,511	217													8,723	1,051
Mu	147	15																	147	15
Nehu	12,500	225			79,400	1,491	6,750	$101											98,650	1,817
Nenue	160	40	1,600	200	46,300	6,945													48,060	7,185
Nóhu											520	26							520	26
Nunu	600	48			202	16													802	64
Ohua					300	75													300	75
O'ililepa											56	7							56	7
Oío			600	30	29,000	8,700					62,560	18,768							92,160	27,498
Olali							600	60											600	60
Ono											10,520	421							10,520	421
Oópu	3,400	102							96	$31			11,246	337					14,742	470
Oópukái											105	8							105	8
Opakapaka											9,431	2,358							9,434	2,358
Opélu					104,948	15,742													104,948	15,742
Opule	15	8			1,300	650													1,315	658
Páka											1,500	125							1,500	125
Pakaikawale									1,000	200									1,000	200
Paki'i							1,610	644	2,000	700	8	1							3,618	1,345
Paláni	1,600	105											185	4					1,785	109
Panuhúnuhú											514	130							514	130
Páopáo	543	18																	543	18
Paupau	200	20																	200	20
Piha	5,000	80			600	8													5,600	88
Póopá'a											727	18							727	18
Pooú											545	50							545	50
Puálu	56	7	120	6							180	25							356	38
Puhi											12,110	2,019	42	3	90	5			12,242	2,027
Uhu					24	2													24	2
Uku											29,892	6,405							29,892	6,405
Uláe	750	8									241	3							991	11
Ulaula											614	129							614	129
Ulua	4,260	410	10,000	600	29,800	1,788					52,646	3,248							96,646	6,046
Úmaúmaleí	80	8																	80	8
Upapálu					490	74					10	1							500	75

U'u			24	1	2,500	25					773	124							3,297	150
Wálu	2,800	140									280	28							3,080	168
Weke	1,300	49			1,717	120													3,017	169
Welea	1,800	90	4,400	880							3,560	534							9,760	1,504
Conch																	430	$108	430	108
Hee															10,894	1,550	6,124	857	17,018	2,407
Honu															440	17			440	17
Ina																	1,100	110	1,100	110
Leho																	900	225	900	225
Limu																	1,525	381	1,525	381
Loli																	300	75	300	75
Muhee	15	8									4	2			14	7	14	7	47	24
Opae									1,300	156			1,400	168					2,700	324
Opihi																	1,646	411	1,646	411
Papai	400	4									76	9					450	54	926	67
Pupu																	175	35	175	35
Ula									963	160							2,610	910	3,573	1,070
Wana																	3,600	576	3,600	576
Total	296,475	17,228	42,852	4,397	359,142	39,852	11,208	964	8,702	1,632	441,291	49,724	22,223	1,117	11,678	1,604	18,874	3,749	1,212,445	120,267

THE FISHERIES OF MOLOKAI.

This island is located midway between Oahu and Maui, and in shape is long and narrow, being 40 miles in length and 9 miles in width, with an area of 261 square miles. The western half of the island is an elevated plain 1,000 feet above the sea, without running water, but covered with grass, while at the eastern end are several deep valleys, with streams of water during the wet season. The northern coast, which is the windward side of the island, is generally precipitous. Outside of the leper settlements on the northern side, nearly all of the population is located on the southern or leeward side of the island. Molokai must have supported a large population at one time, judging from the number of fish ponds still to be seen on the south side of the island. Many of these are abandoned now, owing to the inability of their owners to dispose of the fish to the very small population remaining there. There are no harbors anywhere along the coast; Pukoo and Kaunakakai, the principal settlements, are very small villages. The population of the island, according to the last census, was 2,504, of which over 800 were in the leper reservation.

It is probable that the near future will see a considerable development of the fishery resources of the southern and eastern sides of Molokai. The finest fishing banks of the group lie off this part of the island, and for some years past they have been much resorted to by the line fishermen from Honolulu and Lahaina. Several Honolulu concerns, which are now preparing to engage in fishing on these banks, will make their fishing headquarters on Molokai, where they will use some of the fish ponds for storing their fish until ready to ship. One company began operations this year (1904), with headquarters at Kaunakaki, where it has secured control of several fish ponds. It has several small boats engaged directly in fishing on the banks, and a small gasoline schooner employed in carrying to Honolulu or Lahaina the catch of these, and of such other fishing boats as may enter into satisfactory arrangements. The Inter-Island Live Fish and Cold Storage Company, of Honolulu, also expects to have an important fishing station on the south side of Molokai.

One of the worst features of the fisheries of Molokai is the tremendous destruction of young amaama (called by the natives "pua") in fine-meshed seines. These fish are only an inch or two in length, and are eaten by the natives raw or else slightly scorched over an open fire.

In the early part of 1903 Meyer Brothers secured a number of frogs from Hilo and placed them in a fresh-water mountain lake at Kalae. They also planted carp in this lake several years ago, but this fish has not proved popular as food.

The poisonous qualities of the oópuhúe, or maki maki (*Tetraodon hispidus*), have long been known to the Hawaiians, but as the fish

appears to be wholesome when properly prepared, it is sparingly eaten. The skin and gall bladder are thought to contain the poisonous properties, and if these are properly removed the flesh is said to resemble in flavor the white meat of chicken or turkey. In April, 1903, a powerfully built native of Kamalo, aged about 45 years, died within one hour after eating an oópuhúe. According to Dr. A. Mouritz, of Mapulehu, who treated the patient, the symptoms of oópuhúe poisoning, which manifest themselves very quickly, are as follows:

> Tightness and obstruction in breathing; giddiness, tingling, burning, and creeping sensations; nausea, vomiting, involuntary purging; rapid and irregular heart action; tendency to syncope; cold hands and feet; failing voice, vision, and hearing; body bathed in cold perspiration; pupils markedly dilated; face pale; great prostration; delirium; convulsive twitching of limbs and muscles of face and body. * * * The poison resembles aconite in large doses.

In 1900 there were 128 persons engaged in the Molokai fisheries, while in 1903 there were 300 so employed, a gain of 162. This gain is exclusively among the Hawaiians, the number of Chinese and Japanese having decreased. There is also a considerable increase in the number and value of boats and each form of apparatus used, but the number of fish ponds used commercially decreased by three.

The total yield of the fisheries was 274,331 pounds, valued at $32,389, a very material decrease since 1900. So far as quantity of catch is concerned seines lead, but in value of catch lines slightly exceed the seines. In value of catch gill nets are third, although they are preceded in quantity of catch by bag nets. Cast nets and spears follow in the order named. The principal species taken in the fisheries are akule, ama-ama, aku, oío, and ulua.

The following tables show the condition of the fisheries in 1903:

Table showing by nationalities the number of persons engaged in the fisheries of Molokai in 1903.

	In shore fisheries.
Chinese	6
Hawaiians	290
Japanese	4
Total	300

Table showing the boats, apparatus, fish ponds, etc., in the fisheries of Molokai in 1903.

Items.	Number.	Value.	Items.	Number.	Value.
Boats	78	$6,165	Apparatus—Continued:		
Apparatus:			Spears	24	$24
Seines	a 57	2,355	Fish ponds	12	4,050
Gill nets	b 84	1,440	Shore and accessory property		1,100
Bag nets	11	1,450			
Cast nets	52	520	Total		17,154
Lines		50			

a 5,833 yards. b 12,720 yards.

Table showing by apparatus and species the yield of the fisheries of Molokai in 1903.

Species.	Seines.		Gill nets.		Bag nets.		Cast nets.		Lines.		Spears.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'alaihi							2,200	$176					2,200	$176
A'awa									900	$325			900	325
Ahi									200	10			200	10
Ahólehóle									1,600	141			1,600	111
Aku									18,000	675			18,000	675
Akule	54,100	$1,400			18,828	$480			400	10			73,328	1,930
Ama-ama	15,061	3,765	36,900	$9,225	400	100	5,300	1,325					57,661	14,115
Awa			3,800	308									3,800	308
Awa-awa	200	24											200	24
Aweoweo									900	101			900	101
Hapú'upú'u									600	80			600	80
Hilu	100	8											100	8
Hínaléa									1,960	380			1,900	380
Húmuhúmu									8,100	405			8,100	405
Iheihe	1,700	268			1,000	240			1,600	384			4,300	892
Kahála	300	17							900	52			1,200	69
Kála	100	8			6,100	488							6,200	496
Kálekále	75	8											75	8
Káwakáwa	300	38							6,000	765			6,300	803
Kawelea	80	40											80	40
Kumu	6,550	1,075			6,500	1,062							13,050	2,137
Kupóupóu									290	73			290	73
Laeníhi	250	25											250	25
Lea	1,100	38											1,100	38
Lauhau							1,200	72					1,200	72
Máhimáhi									700	39			700	39
Maíkoíko									100	6			100	6
Malolo	500	25			150	8							650	33
Maníni					4,700	376							4,700	376
Mano	300	60											300	60
Moáno	300	72							4,400	1,056			4,700	1,128
Moi	195	23											195	23
Mu	25	6											25	6
Nehu							750	14					750	14
Nóhu									500	125			500	125
Nunu					2,100	140							2,100	140
Oio			1,200	90					15,000	1,125			16,200	1,215
Olali							820	82					820	82
Ono									600	25			600	25
Oópukái									150	20			150	20
Opélu					1,300	156							1,300	156
Opule	600	300			150	75							750	375
Páka									555	46			555	46

Paki'i							2,250	1,050					2,250	1,050
Paláni	3,500	65							2,000	250			5,500	315
Páopáo	800	240											800	240
Puálu	200	25											200	25
Puhi									2,300	345	1,400	232	3,700	577
Úhu					4,200	700							4,200	700
Úku									1,000	215			1,000	215
Ulaula									1,100	550			1,100	550
Ulua	600	36	2,000	120					8,000	480			10,600	636
Úmaúmaleí	100	20											100	20
Upapálu									113	11			113	11
U'u									444	36			444	36
Weke	330	20			1,600	100							1,930	120
Welea									510	128			510	128
Hee											2,300	150	2.300	150
Honu											250	8	250	8
Muhee	105	13											105	13
Papai	200	24											200	24
Ula	400	65											400	65
Total	88,071	7,748	43,900	9,743	47,028	3,925	12,520	2,719	78,862	7,864	3,950	390	274,331	32,389

The leper settlements.—Near the center of the northern coast of Molokai is a tongue of land about a mile broad and 10 miles long, projecting into the ocean. In 1865 this spit of land was purchased by the then Hawaiian Kingdom and set apart as a reservation for lepers. It is especially well located for this purpose, there being behind the point of land an almost impassable cliff 2,000 to 4,000 feet high. There are 6,348 acres in the tract, most of it fertile soil. On this reservation are two settlements, Kalaupapa and Kalawa, and all known lepers are compelled to reside at one or the other of them, or else leave the islands altogether. The territorial government provides quarters, clothing, and provisions for all its afflicted wards, and takes the greatest precautions to see that they are completely isolated from the rest of the islands and from the remainder of Molokai itself. The territorial board of health has full control of the two settlements and a nonleper can visit them only by its permission, which is exceedingly difficult to obtain. As the only vessel allowed to land at the settlements is the steamer chartered by the board, which makes a weekly trip thither from Honolulu, it is a very easy matter to control ingress to and egress from the settlements. A heavy penalty is provided for other vessels and boats touching or having communication with the settlements.

Some of the lepers were fishermen before being seized with the dread disease, and they have been allowed to continue the same occupation at the settlements. During 1903, 31 natives engaged in fishing and used 4 haul seines, 12 cast nets, 1 bag net, 1 corral net, and 9 spears. Should the fishermen secure more fish than they can dispose of themselves, the board will purchase the surplus at a uniform price of 5 cents per pound, and issue the same to the lepers in the settlements in lieu of their regular meat ration. During the year 1903 the board so purchased from the fishermen 15,028 pounds of fish. Some of the lepers have private means, while others, by working for the board, receive regular wages. These are in a position to purchase supplies for themselves in addition to those furnished by the board, and frequently the fishermen dispose of the choicer varieties in the catch at a higher price than the board pays. Being on the windward side of the island and exposed to the heavy surf caused by the trade winds, fishing is a rather difficult and oftentimes dangerous industry for a considerable part of the year, hence the number of days on which fishing is prosecuted is but few as compared with the southern, or leeward, side of the island. The season of 1903 was an especially poor one for the fishermen. In 1902 they sold to the board 25,191 pounds of fish, and in 1901, 20,085 pounds.

Absolutely none of the fish caught by the lepers is permitted to leave the reservation. Even if the fishermen were allowed to carry them

away there is no convenient market, for, with the exception of the settlements on the reservation, which contain about one-third of the total population of the island, there are very few people living on its northern side, the most of the inhabitants being on the southern, or leeward, side. To reach these by water would necessitate a long journey around one or the other end of the island, while to go overland to the nearest settlement would necessitate an 11-mile journey on foot after the cliff at the back of the reservation had been surmounted.

In 1903, in order to fill out the very small catch of their own fishermen, the board of health purchased 15,753 pounds of fresh fish from the fishermen of Halawa, a small nonleprous settlement some few miles to the westward of the reservation. Even with this addition the total amount to be distributed among an afflicted population of 855 was pitifully small, amounting virtually to 30.35 pounds per year to each person. There has been complaint by persons unacquainted with the circumstances that the board of health was making fresh fish too important an item in the diet of the lepers, but the above would certainly indicate that this contention was not well founded. Some salted and dried fish is also distributed among the lepers, but I am informed that the amount is quite small.

THE FISHERIES OF NIIHAU.

This, the most westerly of the inhabited islands of the group, is 15 miles from Kauai, and has an area of 97 square miles. The greater part of it is a low plain composed of an uplifted coral reef and substance washed down from the mountains, while the hilly portion is destitute of peaks and ridges. It has a population of 172, is used exclusively as a sheep ranch, and fishing is carried on in a very desultory manner by the employees of the ranch and their families. Should more fish be caught than they can consume the surplus is carried across the strait to Waimea, on Kauai, and sold there. A portion of the catch is dried and sold.

The following tables show the condition of the fisheries in 1903:

Table showing the fishermen engaged and the boats, apparatus, and shore property used in the fisheries of Niihau in 1903.

Item.	Number.	Value.
Fishermen:		
Hawaiians	12	
Boats	10	$750
Apparatus:		
Cast nets	7	70
Lines		30
Shore and accessory property		20
Total		870

Table showing by apparatus and species the yield of the fisheries of Niihau in 1903.

Species.	Lines.		Cast nets.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'awa, fresh	100	$10			100	$10
A'awa, dried	300	30			300	30
Aku, fresh	3,600	360			3,600	360
Aku, dried	1,000	100			1,000	100
Ama-ama			3,100	$310	3,100	310
Ea, dried	600	60			600	60
Kála, fresh	200	20			200	20
Kála, dried	400	40			400	40
Moi			1,000	150	1,000	150
Oio	5,000	500			5,000	500
Uku	2,900	290			2,900	290
Ulaula, fresh	800	80			800	80
Ulaula, dried	1,000	100			1,000	100
Ulua, fresh	3,000	300			3,000	300
Ulua, dried	6,200	620			6,200	620
Weke	400	40			400	40
Total	25,500	2,550	4,100	460	29,600	3,010

THE FISHERIES OF OAHU.

Although but third in size, this island is the first in importance and population, Honolulu, the capital, being located upon it. It is 46 miles long by 25 miles broad, but has an irregular quadrangular form, with an area of 598 square miles. It is traversed from southeast to northwest by two parallel ranges of hills separated by a low plane, the highest point of the mountains being 4,030 feet above sea level. The greater part of the coast is bordered by a coral reef, often half a mile wide. This island has two fine harbors that are safe for large vessels at all seasons of the year—Honolulu Harbor and Pearl Harbor. The latter is very large and supports quite important fisheries within its bounds.

Oahu is divided into six districts: Kona (sometimes called Honolulu), Ewa, Waianae, Waialua, Koolauloa, and Koolaupoko. The principal city on the island is Honolulu, with a population of 39,306. Other important towns and settlements are Pearl City, Ewa, Waianae, Waialua, Kahuku, Heeia, and Waimanalo. According to the census of 1900 the total population of this island is 58,504.

An improvement which has done more than anything else to develop and foster the fisheries is the railway which skirts the water nearly all the way from Honolulu to Kahuku, a distance of 71 miles. By generous treatment of the fishermen along its line the railway company has developed a large carrying trade between the fishing grounds along its route and Honolulu, the chief market. Eventually the railroad will be extended completely around the island, making a belt line. Some very fine fishing grounds are located in the region not reached by the railway as yet, and the extension of the line to these will mean much to the fishermen of the island.

One of the most important features of the fisheries of Oahu is the fish ponds, more of these being used commercially on this island than on all the others combined. The fishery rights have also been of far greater importance and value than on any of the other islands. Both of these subjects have been treated in detail elsewhere in this report.

On October 17, 1903, the settlement of Gilbert Islanders (South Sea Islanders) near Honolulu, which formed one of the most picturesque features of the fisheries of Oahu, returned to their former home on Tarawa. They had been in the Hawaiian islands for a number of years, having been brought here by the royal government in the hope that enough could be introduced to offset the rapidly lessening number of natives, but the project was abandoned after several hundred had been introduced. In all 220 of them left, 85 from Lahaina and 135 from Honolulu, but 3 remaining on the islands. These people were quite skillful fishers and were the chief users of baskets, a most effective mode of fishing.

In many of the irrigation ditches for transporting water to the rice fields and taro patches, and in the trenches between the rows of Chinese bananas, are to be found china-fish, gold-fish and oópu. A few of these are sold, but the greater part are consumed by the workers in the fields and their families.

There are a few small fresh-water streams in the island, the principal ones being Kaneohe, Nuuanu, Piinaio, and Waiawa. During the rainy season these streams are raging torrents, but during the rest of the year they are almost dry or form numerous pools. Among the indigenous species found in them are the oópu and opae, and china-fish and gold-fish have been introduced. A considerable proportion of the catch from these streams is made by people living along the banks, who consume the most of it themselves. As the fishing in these waters is quite insignificant it has been included in the regular tables showing the shore fisheries.

In 1901 and 1902 some frogs from Hilo, Hawaii, were introduced in various places around Honolulu, as it was thought they might aid in ridding vegetation of the Japanese beetle, an insect which was rapidly becoming a pest.

The fisheries of Oahu show a most gratifying increase during the last few years. In 1900 there were 1,106 persons engaged in fishing, while in 1903 there were 1,478 so employed, a gain of 372. The most remarkable feature of this is the great increase of Japanese in recent years. In 1900 there were 259 Japanese fishing, but in 1903 they had increased to 707, a gain of 448. During the same period the number of natives so engaged dropped from 654 to 533, a loss of 121. The Chinese increased from 173 to 197, and the South Sea Islanders from 18 to 35.

Not much change is noted in the total value of investment in the fisheries, the increase being $14,794. The greater part of this is made up by the increased number of boats and lines used.

The total yield of the fisheries in 1903 was 3,515,850 pounds, which sold for $373,819. So far as quantity is concerned, lines occupy first place in the fisheries, but in value of catch gill nets are first. Scoop and dip nets occupy third place, followed by bag nets, hands, seines, cast nets, fish baskets, spears, traps, opae baskets and pots, in the order named. The most noticeable feature is the enormous falling off in the catch of malolo. In 1900 this species was the most important, 571,002 pounds, valued at $142,773, having been secured. In 1903 the catch amounted to only 34,907 pounds, valued at $3,490, a decrease of 536,095 pounds in quantity and $139,283 in value. This is accounted for largely by the fact that the natives, who prosecuted this fishery on a large scale for many years, have been gradually dropping out of the business, partly because of the rapidly increasing competition of the Japanese, and partly because of their own indifference. At present the leading species in the fisheries of Oahu is the aku, although the value of the catch of this species is exceeded by that of the ama-ama, akule and awa.

The following tables show the extent of the industry in 1903:

Table showing by nationalities the number of persons engaged in the fisheries of Oahu in 1903.

	In shore fisheries.		In shore fisheries.
Chinese	197	Japanese women	23
Hawaiian men	380	Portuguese	3
Hawaiian women	153	South Sea Islanders	35
Italians	3		
Japanese men	684	Total	1,478

Table showing the boats, apparatus, fish ponds, and property used in the fisheries of Oahu in 1903.

Item.	Number.	Value.	Item.	Number.	Value.
Boats	431	$38,325	Apparatus—continued.		
Apparatus:			Baskets (opae)	47	$21
Seines	[a]25	1,570	Spears	56	56
Gill nets	[b]496	10,350	Pots	2	20
Bag nets	29	1,930	Fish traps or pens	3	1,500
Cast nets	80	800	Fish ponds	67	151,900
Dip and scoop nets	133	319	Shore and accessory property		3,835
Lines		1,182			
Baskets (fish)	50	500	Total		215,338

[a] 1,810 yards. [b] 26,980 yards.

Table showing by apparatus and species the yield of the fisheries of Oahu in 1903.

Species.	Seines.		Gill nets.		Bag nets.		Cast nets.		Scoop and dip nets.		Lines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'alaihi	3,200	$256			2,908	$233	4,553	$366				
A'awa	2,017	303	4,034	$605								
Abaáha			609	49					4,000	$320		
Ahi							130	10			92,000	$7,260
Ahólehóle	5,500	440	6,770	532							4,674	374
Aku											501,914	20,077
Akule			151,652	13,364	88,376	7,376	65,201	5,216			98,202	7,856
Ama-ama	40,813	8,163	265,252	53,050	13,000	2,600			158,130	31,626		
Awela			162	16								
Auau			232	23								
Awa	33,048	3,305	162,681	16,473					86,382	8,638		
Awa-awa			41.358	12,407								
Aweoweo			51,021	3,571								
Carp									400	32		
China-fish									1,090	323		
Gold-fish									8,042	659		
Hapú'upú'u											64,245	8,352
Hihimánu											3,500	140
Hilu			3,220	129								
Hinaléa											5,000	200
Húmuhúmu			1,606	48							6,424	193
Iheihe			10,239	1,229	20,478	2,457						
Kahála											34,144	1,405
Káku			7,246	870								
Kála	7,000	700	20,694	1,035								
Kálekále											155	8
Káwakáwa											60,000	15,000
Kawelea											1,185	178
Kihikiki	92	5										
Kóle			73	29								
Kumu	15,745	3,149	20,000	4,000	20,000	4,400	4,000	800	5,000	1,100		
Kupipi			112	14								
Kupóupóu											155	31
Laeníhi	14,552	1,455	2,000	200							1,638	164
Lae			2,464	197							2,463	195
Lauhau			74	7			100	15				
Máhimáhi											33,138	5,965
Maii'i			4,060	365								
Maikoiko			1,000	60							159	10
Maka'a											301	120
Malolo			800	80	34,107	3,410						
Mamámo			100	10								
Manini			8,000	640	6,000	488						

Table showing by apparatus and species the yield of the fisheries of Oahu in 1903—Continued.

Species.	Seines.		Gill nets.		Bag nets.		Cast nets.		Scoop and dip nets.		Lines.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mano			2,000	$20	1,200	$12					5,000	$50
Mikláwa	1,000	$10	1,188	96								
Moáuo	14,000	1,260	4,430	399							36,860	3,317
Moi			58,996	1,770								
Mu			226	7								
Nenue			2,851	713								
Nóhu											1,770	230
Nunu			105	5	9,000	450						
Olo			8,000	400							14,683	2,496
Omakaha	1,509	272			100	18						
Omilu											18,430	1,474
Ono											16,450	1,452
Oópu			1,200	72					10,113	$903		
Opukapaka			2,612	313							5,000	500
Opélu	31,346	3,762	50,000	6,000							50,500	6,060
Opule					200	32					821	131
Pakí'i	503	50					503	$50				
Paláni			2,500	188					1,500	113	576	43
Póopá'a			5,380	323							2,000	120
Pooú			600	21								
Puálu	6,000	450	7,000	525					4,600	345	4,000	300
Puhi			200	10							12,715	536
Uhu			8,000	1,280	12,881	2,060						
Uku			97	29							8,900	2,670
Uláe			541	32							541	32
Ulaula			2,000	1,000							5,951	2,975
Ulua			65,000	3,900							90,000	7,200
Úmaúmalei			458	36								
Uouóa			10	1								
Upapálu					1,000	300	300	90			287	86
U'u			55,000	4,400							43,000	3,440
Weke			60,000	4,200	45,000	3,600					3,000	240
Hee											18,841	1,060
Honu			520	78								
Muhee			96	48								
Opae			550	83								
Papai			2,300	138					60,777	3,647		
Ula			7,615	1,275					10,000	1,000		
Total	176,325	23,580	1,114,934	136,368	254,253	27,436	74,787	6,547	330,084	48,706	1,218,622	101,940

Table showing by apparatus and species the yield of the fisheries of Oahu in 1903—Continued.

Species.	Baskets (fish).		Baskets (opai).		Traps (fish).		Pots.		Spears.		Hands.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
A'alaihi													10,661	$855
A'awa													6,051	908
Ahaáha													4,609	369
Ahi													92,130	7,270
Ahólehóle													16,944	1,316
Aku													501,914	20,077
Akule					620	$50							404,051	33,862
Ama-ama													477,195	35,439
Awela													162	16
Auau													232	23
Awa													282,111	28,416
Awa-awa													41,358	12,407
Aweoweo													51,021	3,571
Carp													400	32
China-fish													1,090	323
Gold-fish													8,042	659
Hapú'upú'u													64,245	8,352
Hihimánu									225	$9			3,725	149
Hilu													3,220	129
Hinaléa	3,147	$125											8,147	325
Húmu-húmu													8,030	211
Iheihe													30,717	3,686
Kahála													34,144	1,705
Káku													7,216	870
Kála	3,347	335											31,011	2,070
Kálekále													155	8
Káwakáwa					1,554	388							61,554	15,388
Kawelea													1,185	178
Kihikiki													92	5
Kôle													73	29
Kumu	3,000	660							2,300	506			70,045	14,615
Kupipi													112	14
Kupóupóu													155	31
Laeníhi													18,190	1,819
Lae													4,927	392
Lauhau													174	22
Máhimáhi													33,158	5,965
Maii'i													4,060	365
Maikoiko													1,159	70
Maka'a													301	120
Malolo													34,907	3,490
Mamámo	869	87											969	97
Manini	10,000	800											21,000	1,928
Mano					600	6			500	5			9,300	93

Table showing by apparatus and species the yield of the fisheries of Oahu in 1903—Continued.

Species.	Baskets (fish).		Baskets (opai).		Traps (fish).		Pots.		Spears.		Hands.		Total.	
	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.	Pounds.	Value.
Mikiáwa													2,188	$106
Moáno													55,290	4,976
Moi													58,996	1,770
Mu													226	7
Nenue													2,871	713
Nóhu													1,770	230
Nunu													9,105	455
Oio													22,683	2,896
Omakaha													1,609	290
Omilu													18,430	1,474
Ono													16,450	1,452
Oópu													11,313	975
Opakapaka													7,612	813
Opélu													131,846	15,822
Opule	800	$128											1,821	291
Pakií													1,006	100
Paláni	5,000	375							800	$60			10,376	779
Póopá'a													7,380	443
Pooú													600	24
Puálu	15,000	1,125							2,000	150			38,600	2,895
Puhi	8,000	400							2,000	100			22,915	1,046
Uhu	4,000	640											24,884	3,980
Úku													8,997	2,699
Uláe													1,082	64
Ulaula													7,951	3,975
Ulua													155,000	11,100
Umaúmaleí													458	36
Uouóa													10	1
Upapálu													1,587	476
U'u													98,000	7,840
Weke					2,000	$160							110,000	8,200
Hee									20,000	1,200	17,681	$1,061	56,522	3,321
Honu									2,000	300			2,520	378
Ina											3,000	360	3,000	360
Limu											41,000	1,025	41,000	1,025
Muhee													96	48
Olepa											300	24	300	24
Opae			4,475	$895							1,800	270	6,825	1,248
Opihi											70,200	10,530	70,200	10,530
Papai											12,000	1,440	75,077	5,225
Ula							3,500	$200	20,000	2,000	30,000	3,000	71,115	7,475
Wana											5,177	828	5,177	828
Total	53,163	4,675	4,475	895	4,774	604	3,500	200	49,825	4,330	181,158	18,538	3,515,850	373,819

NOTES ON THE FOOD AND PARASITES OF SOME FRESH-WATER FISHES FROM THE LAKES AT MADISON, WIS.

By WILLIAM S. MARSHALL and N. C. GILBERT.

NOTES ON THE FOOD AND PARASITES OF SOME FRESH-WATER FISHES FROM THE LAKES AT MADISON, WIS.

By William S. Marshall and N. C. Gilbert.

The following observations regarding the food of some of our fresh-water fishes and the parasites living on or within them were nearly all made during the spring, summer, and autumn of 1902 and 1903. The fishes were examined principally for their parasites, but in connection with that examination it was decided to note the food contents of each, since this could easily be done after the fish had been opened for parasites. The work originally planned was much more extensive than the following notes would indicate, but the removal of one of us from Madison brought it to an end before very much had been accomplished. Doubting that there would be opportunity to continue and complete the work as it had been laid out, it was thought best to publish the following notes, although but very few specimens of some species of fishes have been examined. The stomach contents were not kept, and we have only our original notes to refer to, which makes impossible a more exact determination of all we found.

The lakes from which the fishes were taken are adjacent to Madison. Lake Mendota, the largest, bordering in part on the University grounds and being thus easy of access, furnished the most of our material. Lakes Monona and Wingra were both visited, but only a comparatively small number of fishes was taken from either. A few of the black bass were sent to us from Round Lake, Washburn County, Wis.

The fishes were in part caught with hook and line, but the greatest number were taken with a trammel net. A map of Lake Mendota was platted so that we could record quite accurately the part of the lake from which each fish was taken, this information to be used in determining what differences, if any, the bottom, plants, depth, etc., made upon the food of the fish and, through the food, upon the kind of parasites found. Our notes have been carefully examined with this in view, but without any definite results, the fish from one part of the lake averaging, as a rule, the same as the fish from any other part. This does not, however, hold true for perch caught near the shore

as compared with those taken in the deeper water, the latter using plankton for food much oftener and in greater quantities than the former. A distinct difference was also found in the food of the perch living near the shore and those caught during the winter through the ice. These latter were taken well out in the lake, and were so different from the others in food contents and scarcity of parasites that they are entitled to special mention.

The scarcity of literature on the food of fresh-water fishes is very noticeable, and we could find but little information on the subject. When one considers the amount of work that is being done by the federal and state fish commissions in stocking our inland waters, it is surprising to find that so few observations have been made and recorded concerning any of the important economic questions bearing on this subject.

In classifying our fishes we have followed Jordan and Evermann.

1. *Lepisosteus osseus*, gar pike.

A single specimen of this fish was obtained in October from Lake Mendota. No food was found in the alimentary tract. Two cestodes and a few small trematodes were present, none of which has yet been identified.

2. *Amia calva*, dog-fish.

Thirteen specimens of dog-fish were examined, 4 of which were without any food; 7 of the 9 in which food was found contained craw-fish, the other 2, minnows.

Parasites were very prevalent, every fish having them in considerable numbers. The following table gives the kinds of parasites found, the parts of the host in which they occurred, and the number of fish in which each kind of parasite was found:

	Mouth.	Stomach.	Intestine.	Rectum.
Trematodes	5	6		
Cestodes		13	13	
Nematodes			1	
Acanthocephala			2	1
Leeches	1			

The trematodes were all *Azygia tereticolle*, which fluke was also present on the gills of 2 fishes. One fish had an encysted cestode in the spleen.

The prevalence of cestodes was noticeable, they being found in every fish examined and in great abundance, 100 to 300 occurring in many of the fish. There were at least 2 species of cestodes and 2 species of Acanthocephala present. The frequent occurrence of cestodes in the stomach was due to the fact that many which were found in the intestine were fastened to the wall of the stomach, stretching from there

far into the intestine. In different kinds of fishes, *Amia* included, it was noticed that the cestodes apparently moved forward in the alimentary tract after the death of the host, often protruding into the mouth. Forbes (*c*, *d*) examined young specimens of *Amia* and found their food to consist of may-fly larvæ, ostracods, and algæ, none of which we found in the mature specimens; in older fish he found fish, mollusks, and crustacea.

3. *Ameiurus nebulosus*, common bullhead.

The 5 specimens examined were caught in Lakes Mendota and Monona during the months of April, July, and August. The food contained in the different parts of the alimentary tract was in such a condition as to make impossible a determination of its separate parts. In one fish a minnow could be recognized and in another the remains of a crawfish.

The most abundant parasites were cestodes, found in the intestine of 5 fish, 3 of these also containing them in the body cavity. Acanthocephala were found in large numbers in the intestine of 4 fish, liver cysts in 4. Trematodes and nematodes were found in the intestine of but a single fish. The cestodes found were 2 species of *Corallobothrium* and a species of *Proteocephalus* (?).

4. *Erimyzon sucetta*, chub sucker.

A single specimen caught in April was without food and had as parasites only a few Acanthocephala in the intestine.

5. *Esox lucius*, common pike.

The 35 specimens examined were all taken from Lake Mendota during April, May, or November. Thirteen of the entire number were without food, the remaining 22 showing either a small or a large quantity of food within the alimentary tract. The different kinds of food, and the number of fish in which each kind was found, can readily be seen from the following table:

Food.	Fish in which found.	Food.	Fish in which found.
Minnows	17	Crawfish	1
Lepomis incisor	1	Leeches	1
Small Esox	1		

Forbes (*c*, *d*) found the food of the pike to be almost exclusively other fish, this being true of 36 of the 37 specimens he examined. It will be seen at once that our results are almost identical, but 2 of the 35 pike examined by us containing any food other than fish. We also found that as a rule but one or two fish were present in the alimentary tract; 2 of the pike we examined were exceptional, in that one contained 10 and the other 20 minnows.

The kind of parasites and their prevalence in the different parts of the alimentary tract were as follows:

	Mouth.	Œsophagus.	Stomach.	Intestine.
Trematodes	3	3	12	....
Cestodes	......	....	9	27
Nematodes	......	....	10	19
Acanthocephala	......	....	....	1

Every fish examined contained some parasites. Cestodes and nematodes were present in more than half, while Acanthocephala occurred in but a single fish. It was noticeable that fish caught in April and May were much freer from parasites than those caught in November. The trematodes were nearly all *Azygia tereticolle.* One cestode was a species of *Proteocephalus.*

6. *Pomoxis sparoides*, calico bass.

Three specimens of calico bass were caught during July in Lake Wingra. They had plankton only as food. The only parasites found were two leeches, one on the tongue of one fish and one on the roof of the mouth of another, and a few small cysts on the outer wall of the stomach.

7. *Ambloplites rupestris*, rock bass.

Sixteen rock bass were caught during May and July in Lake Mendota. The food, found in the 13 fish containing any, consisted of insect larvæ in 2 and crawfish in 12. The specimens examined by Forbes (*b*) were found to have eaten insect larvæ much oftener than the bass from Lake Mendota.

Three fish were without parasites. In the 13 in which they were found the distribution was as follows: Trematodes in 1, nematodes in 3, and Acanthocephala in 12. Almost as noticeable as the fondness for crawfish as food was the prevalence of Acanthocephala; the entire absence of cestodes is also noticeable.

8. *Lepomis incisor*, bluegill.

Specimens were taken in March, April, and July from Lakes Mendota and Wingra. Thirty fish were examined, 20 containing food, as follows:

Food.	Fish in which found.	Food.	Fish in which found.
Plant tissue, mostly *Ceratophyllum*	9	Gammarids	2
Plankton	13	Leeches	1
Insect larvæ	9	Snails, mostly *Physa ancillaria*	1

Thirteen of the fish were entirely without parasites, as far as a general examination showed, and the other 17 contained the following:

	Stomach.	Intestine.	Rectum.	Body cavity.
Cestodes	1			1
Nematodes	1		3	
Acanthocephala		6		

Leech in mouth, 1; cestode or nematode cysts in the liver, 6; cysts in mesentery, 1.

9. *Eupomotis gibbosus*, common sun-fish.

Six specimens only were examined. Of these 5 contained food, consisting of insect larvæ, snails, and small bivalves. One sun-fish had no parasites; the other 5 contained each a number of Acanthocephala, encysted in the mesentery of 3 fish and mature in the intestine of the other 2.

10. *Micropterus dolomieu*, small-mouthed black bass.

But 5 specimens were examined, all caught during July in Lake Mendota. One bass was free from food; in the stomachs of the other 4, crawfish were found. Cestodes were more abundant than any other parasite, and were found in the stomach, body cavity, and ovary. One species was *Proteocephalus ambloplites*. *Azygia tereticolle* was found once in the mouth and once in the stomach. Nematodes and Acanthocephala were found in the intestine of 3 of the bass examined. Encysted worms were found in the wall of the stomach of one fish and in the liver of another.

11. *Micropterus salmoides*, large-mouthed black bass.

Nearly all of the fish examined were taken from Lake Mendota. Only four were caught in Lake Monona and the same number in Lake Wingra. Most of the specimens from Lake Mendota were caught in the trammel net, and were taken on the southern shore near the mouth of or just within a small creek, which, in this part, was from 3 to 5 feet in depth. The majority of the fish were caught in April or May, a few only during July and August. To those already enumerated were added 4 bass from Round Lake in the northern part of the state. A careful study of the records failed to reveal any differences in food or parasites in the fish from the different lakes, except that the 4 from Round Lake all had copepods on the gills, there being among all the other fish but a single specimen so infected.

Of the 42 fish examined, 29 contained food which could be recognized. The other 13 showed nothing the nature of which could be distinguished. The following table gives the kinds of food found and the number of fish in which each kind was present:

Food.	Fish in which found.	Food.	Fish in which found.
Minnows	17	Crawfish	2
Other fish	5	Frogs	2
Insect larvæ	6	Leeches	2

Twenty-two of these fish contained but one kind of food, and then generally but one or two specimens of the latter was large. One bass had eaten 4 minnows and another 2 frogs.

Forbes (*c*, *d*) found that this species of black bass contained about the same variety of food as recorded by us; he found that fish constituted the largest percentage of food, and in much smaller quantities crawfish, insect larvæ, and algæ.

None of the bass we examined was free from parasites, the nearest approach being one fish from which we took but a few cysts in the mesentery. Cestodes were more prevalent than any other parasites, although Acanthocephala were nearly as numerous. The following table gives the places in which parasites were found and the number of fish in which each kind was present:

	Mouth.	Œsophagus.	Stomach.	Cæcal tubes.	Intestine.
Trematodes	8	2	20	4	1
Cestodes	......	......	10	3	28
Nematodes	......	......	4	1	7
Acanthocephala	......	......	9	3	28

Copepods (*Ergasilus*) on gill, 4; cestodes in ovary, 4; cysts in mesentery, 1; cestodes in body cavity, 1; cysts in liver, 2.

The trematodes were *Azygia tereticolle*, *A. loossii*, *Cæcincola parvulus*, and *Leuceruthrus micropteri*. One of the cestodes was a species of *Proteocephalus*.

12. *Perca flavescens*, yellow perch.

The perch, caught mostly with hook and line, were taken from Lakes Mendota, Monona, and Wingra—all but a few from the first-mentioned lake. The Lake Mendota perch were nearly all caught near the shore, a few only coming from deep water. An exception to this, however, was a lot of perch, 16 in number, purchased in February from fishermen, who caught them through the ice at quite a distance from shore and in deep water. The food and parasites of these were quite different from what we found in the others, and, although at present included with the others, separate mention of them will be made later. Excepting these, all were caught in April, May, or July—more during May than at any other time.

Seventy-two perch were examined, in only 9 of which were parasites absent. A few of the others had no parasites in the alimentary tract, but contained cysts in the mesentery or liver. Fifty-six of the perch contained food the nature of which we could determine, and of the remaining 16 a few had food remains in the lower part of the intestine or in the rectum nothing as to the nature of which was recognizable. The following table gives the different kinds of food and the number of fish in which each kind was found:

Food.	Fish in which found.	Food.	Fish in which found.
Insect larvæ	39	Plant remains	2
Gammarids	14	Plankton	16
Snails, mostly Physa ancillaria	6	Minnows	2
Crayfish	9	Fish spawn	3

The 39 perch in which insect larvæ were found contained, as far as we could determine, phryganid larvæ in but 1 and dragon-fly larvæ in 9 fish. Thirty-six of the entire number contained but a single kind of food, 15 had 2 kinds, 2 had 3 kinds, and 3 were found with 4 kinds of food. In nearly every perch in which more than one kind of food was present, insect larvæ were found. Forbes (*b*) gives the food of the perch he examined and we note a great similarity to what we recorded. He found that a number of fish were eaten by the perch he examined from Lake Michigan, due, no doubt, to the smaller amount of insects, crustacea, and mollusks present in the large lake.

The following table will show the kinds of parasites found and the abundance and distribution of each kind in their hosts:

	Stomach.	Cæcal tubes.	Intestine.	Gall bladder.
Trematodes	10	29	7	2
Cestodes	1	....	2	....
Nematodes	5	5	6	....
Acanthocephala	7	3	14	....

Clinostomum heterostomum on gills, 8; copepod (*Ergasilus*) on gills, 9; cestode and nematode liver cysts, 39; cysts in mesentery, 6; cysts in wall of stomach, 2.

The trematodes were nearly all *Distomum nodulosum*, which was by far the most prevalent parasite. The number of times trematodes were found in the gall-bladder was far greater than given in the table, many fish having been examined without being recorded. In late July and early August perch were found with a small immature fluke present in considerable numbers in the gall-bladder, more than half the specimens examined being so infected. It occurred to us that this might be the young form of *D. nodulosum*, which is probable, although, the specimens in the gall bladder being immature, it was impossible to make a direct comparison. In more than half of the perch examined the liver contained cysts; many of these we opened and found that they inclosed either a young cestode or a young nematode. The nematode cysts were generally smaller and firmer than those containing the cestodes, but it was impossible, unless every one was opened, to be sure of the contents. There was undoubtedly but a single species each of cestode and nematode forming the cysts.

The 16 perch caught during February through the ice were taken much farther from shore than any of the others we examined. Fourteen of these had fed exclusively upon plankton. They contained as large a proportion of encysted parasites as any of the other perch,

but were much freer from mature forms. Two contained a small number of Acanthocephala, 2 in one fish and 4 in another, and in 8 of the 16 were found specimens of *Distomum nodulosum*.

Nearly all of the perch taken in winter and early spring contained a number of *D. nodulosum*, which were in every case filled with eggs. When the flukes were taken from the fish and placed in water, they would in a few hours invariably burst and a large mass of dark-shelled eggs would drop to the bottom of the dish. The perch caught during August were not so likely to have this fluke in the cæca, but many of them contained the small, immature fluke in the gall bladder.

13. *Roccus chrysops*, white bass.

Four specimens were taken in July from Lake Mendota. Three of these were without food, the other contained insect larvæ. Parasites were not abundant. Nematodes were present in the stomach of 2 and in the intestine of 1 bass, and Acanthocephala were taken from the stomach of a single specimen. Forbes (*c*, *d*) found these fish to have eaten may-fly and dipterous larvæ very abundantly, and in the stomach of one he found a sun-fish. Forbes (*c*, *d*) found insect larvæ to be the principal food of the white bass, and also found, in small quantities, fish and crustacea.

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THE GERMAN CARP IN THE UNITED STATES

By LEON J. COLE

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THE GERMAN CARP IN THE UNITED STATES.

By Leon J. Cole.

INTRODUCTION.

For a number of years there appears to have been in many sections of this country an increasing popular prejudice against the German carp. These fish were distributed very generally throughout the United States something over twenty years ago, with the idea that they would be extensively raised in ponds and so provide a supplementary income from small inland waters which were unsuitable for other fishes, or from land upon which artificial ponds could be constructed. It was inevitable that many of the fish should escape into the natural waters of the country; and within a few years many of our rivers and lakes were teeming with carp, for which, at that time, there was little or no market. With persons who had been able to obtain in abundance many species of our finer native fishes, the coarser flesh of the carp found little favor, and, under the circumstances, it was perhaps but natural that prejudice should arise, especially because the carp was supposed to be injuring the existing fisheries. In some cases the adverse opinions were founded upon facts and a knowledge of the habits of the fish; more often they were the repeated hearsay born of suppositions and complete ignorance of the subject or of misinterpreted observations. The newspapers also took the matter up, and the carp was decried on all sides without stint.

In the summer of 1901, in order to obtain evidence upon the matter, the writer was appointed by the United States Bureau of Fisheries (then the United States Commission of Fish and Fisheries) to make an investigation of the habits of the carp and to gather any available information relative to its usefulness or obnoxiousness. The work was done in connection with the general biological investigation of the Great Lakes under the general direction of Prof. Jacob Reighard, of the University of Michigan. Professor Reighard was not in active charge of the work, however, in 1901, Prof. H. S. Jennings, then also at the University of Michigan, acting as director during that season. I take pleasure in thanking both Professor Reighard and Professor Jennings for their interest in the investigation and for their readiness at all times to do everything in their power to further the work.

Probably the two regions in the United States where carp are found most abundantly are about the western end of Lake Erie and in the Illinois River and its tributaries. This investigation was begun, however, at Lake St. Clair, this locality being chosen because of such complaints as the following, which appeared in a Port Huron paper:

FISH IN LAKE ST. CLAIR—THE CARP ARE RAPIDLY DESTROYING ALL THE OTHER KINDS.

G——— B———, an old fisherman, who has plied his trade on Lake St. Clair three miles above Mount Clemens for twenty-three years, says in three years more there will be no fish except carp left in the lake. The carp eats the spawn and destroys the perch, bass and other good fish in those waters, and the supply is already much reduced. Mr. B——— suggests that the government offer a bounty of 3 cents or so for the destruction of the carp in order to save the other fish.

This particular paragraph is quoted because it gave the starting point for the field work, and because it illustrates so well the general tone of complaint against the carp. The shallow bays of the delta occupying the upper fourth of Lake St. Clair afford an excellent place for carp—except that possibly the water averages a little cold for their most prolific development—and they are to be found there in considerable numbers. Furthermore, the usual comparative clearness of the water makes it easier at times to observe the fish than in the muddier waters in which they are usually found. When the carp are rooting about in the bottom for food, however, even clear water is made so roily that there is little chance to watch them.

After about three weeks at the St. Clair Flats, the remainder of the summer, until August 31, was spent on Lake Erie, especially at the upper end. During the last week in August all of the important wholesale fish houses on the west and south sides of Lake Erie, from Detroit to Buffalo, were visited to obtain figures as to the magnitude and value of the carp fisheries of the lake. In November, 1901, about three weeks were spent on Lake Erie, principally at Port Clinton and Put-in Bay, in order to determine the relation of carp to the whitefish, which were in the height of their spawning season at this time.

In 1902 it was not practicable to begin the field work until after the 1st of July. As before, Lake St. Clair was first visited, but the conditions there being unfavorable on account of heavy storms, which made the water roily, investigations were renewed on Lake Erie, especially at Port Clinton and at Sandusky. During the last season of the investigations, in the summer of 1903, with headquarters in Sandusky, the work was conducted for about three weeks, during the spawning season of the carp, most of the time from a camp in the marsh, some 20 miles above the city, near where the Sandusky River opens into the large bay of the same name.

In addition to the observation of the general habits of the carp in waters where it has become adapted to a new environment in such a short time, several special problems were kept in mind. Thus a study

was made of the abundance and distribution of carp in relation to the conditions existing at various places, and measurements and records were taken to determine if possible whether the fish had changed perceptibly in accommodating itself to these conditions.

Most of the time, however, was given to the more strictly economic side of the question, and hence, either on account of their uncompleted state or because of their technical nature, the results of certain lines of the study have been omitted from the present report. One of the more strictly economic questions was the relation of the fish to aquatic vegetation, the destruction of which was being deplored, particularly by sportsmen, who maintained that the best food of many of the ducks, such as the canvasback and redhead, was fast being destroyed by the carp. It was also to be determined how far, if at all, carp interfere with the spawning of other fishes, and whether they eat the eggs and prey upon the young of other fishes, and if so, to what extent. It was claimed that they were especially detrimental to bass and white-fish—the former one of the greatest favorites of the sportsmán, the latter one of the most valuable food-fishes of the Great Lakes.

Offsetting the possible harm done by the carp to vegetation and to the fisheries must be its own value as a food-fish; for the carp fishery has within the last few years, in the regions of the carp's greatest abundance, grown to be an industry of no mean proportions. Must the carp, then, be unconditionally condemned, or should we find that, if properly utilized, its value would compensate for the degree of damage it undoubtedly does? It is hoped that the conclusions reached in the following pages may do much toward settling this question, though there are still many points upon which fuller information is desirable.

In order to make the report more useful to those who are interested in the carp, it has been thought best to include a general description of the fish, its habits, and its history. The figures of the different varieties of carp here reproduced (pl. I) are from drawings made for the Bureau of Fisheries from fish in its ponds in Washington soon after the introduction of the species into this country. The photographs and other figures are by the author.

It is impracticable to mention here all to whom I am indebted for assistance of one kind or another in the prosecution of my investigations. I am under especial obligations, however, to Messrs. Cleaver, of the firm of R. Bell & Co., Port Clinton, who not only furnished me a place in which to work in their fish house, but placed at my disposal, without cost, whatever carp were necessary for my work. The Bense Fish Company (which has since changed hands), of the same city, extended to me similar privileges. It was frequently necessary for me to call upon Mr. S. W. Downing, superintendent of the Bureau of Fisheries hatchery at Put-in Bay, for aid, which was furnished with

uniform courtesy. Through the kindness of Prof. Herbert Osborn I was enabled, when in Sandusky, to make my headquarters at the Lake Laboratory of Ohio State University, where I had the use of a table for considerable periods during the summers of 1901 and 1902. And, finally, I wish to express my gratitude to the many fishermen who took great interest in my work, who gave me whatever information was at their disposal, who permitted me to accompany them on their fishing trips, who shared with me their food, and who were my companions in camp for weeks at a time. Other special acknowledgments have been made in their proper places throughout the report.

THE SPECIES *CYPRINUS CARPIO* LINNÆUS.

DESCRIPTION.

Within the past decade the carp has become so generally distributed throughout the United States and so abundant in some places that nearly everybody is more or less familiar with it in a general way, but it has been almost universally neglected in the descriptive works in this country, further than a simple statement of its occurrence. It may therefore be well to give a brief description of the carp and its principal varieties.

The carp belongs to a family of fishes (Cyprinidæ) best represented in America by the minnows (especially of the genus *Notropis*) which abound in most of our lakes and streams. In the eastern United States the members of this family are all small, the largest rarely attaining 18 inches in length, while the smallest is scarcely 2 inches long when adult. The Old World species are generally much larger than this, and on the Pacific coast there are a few which reach a length of 5 or 6 feet, and which are also apparently more closely related to the European forms in structure.

Scientifically the carp is known as *Cyprinus carpio*, the name given to it by Linnæus. It varies greatly in many of its characters, a condition probably brought about in large part by its state of domestication, or semidomestication, for a number of centuries. In shape it varies from a long, rather slender fish (pl. I), whose height scarcely equals one-fourth its length, to a deep form nearly or quite half as high as long. The greatest height is at the anterior end of the dorsal fin. In all cases, however, the body is rather strongly compressed laterally, the cross section never approaching close to circular. The greatest breadth is normally a short distance back of the head, but the bodies of female fish are often, before the breeding season, distended with roe to a considerably greater breadth. This dimension in normal individuals usually equals less than half the height. The snout is blunt, and in typical forms the dorsal outline rises from the snout in a nearly uniform bow or arch to the base of the dorsal fin.

The length of the head, from the tip of the snout to the posterior edge of the gill-cover or operculum, is in the neighborhood of one-fourth the length of the fish[a], but is usually considerably less than the height. It varies considerably in individuals and with age. The eye is situated slightly less than halfway back on the head and on a line from the tip of the snout to the upper end of the branchial opening. The eyes are not quite circular, but are elongated slightly in a direction parallel to the dorsal side of the head, and their long diameter is contained six to seven times in the length of the head. The mouth when closed is nearly horizontal, the gape reaching about halfway to the anterior margin of the eye. At the corners of the mouth are two short barbels, usually a little longer than the diameter of the eye, yellow or reddish in color, which are, however, longer than two olive colored ones on the upper jaw. Both sets are variable, and, according to Seeley (1886, p. 95), may be unsymmetrical on the two sides or frequently wanting entirely.[b] The lips are rather thick and fleshy, adapted to vegetable feeding, the lower somewhat shorter than the upper. The tongue is smooth. The palate is covered with a white and very sensitive skin ("carp's tongue"). The nostrils lie immediately anterior to the eyes and are double, those of each side being separated by a small projecting flap of skin. The anterior nostril is the larger.

The dorsal fin arises anterior to the median point in the length of the fish and slightly in advance of the ventrals, and extends back even with the posterior end of the anal fin. The base of the dorsal fin equals rather more than a third of the length of the body, and its greatest height (at the second and third soft rays) is equal to about a third of its length. After the first two or three soft rays, of which there are 18 to 22 in all, the remainder are only one-half to two-thirds as high, so that the free margin of the fin has a rather sharp reentrant angle at this point. Three or four (usually three) spiny rays precede the soft rays, the most posterior one being the stoutest and longest, with the extreme end usually soft and flexible; this soft portion is often broken away in older fish, however, leaving the ray with a hard, sharp point. The posterior border of this ray is serrated, the serrations or teeth, which have their points directed downward, lying on each side of a median groove and increasing in size from below upward.

The height of the anal fin is greater than its length at the base, which is about equal to one-fourth the length of the base of the dorsal. It is composed of 3 spiny rays and 5 or 6 soft, articulated rays. The second stout, spiny ray is similar to that of the dorsal fin. The first of the

[a] Throughout the description "length" is considered from the tip of the snout to the *base* of the caudal fin, or, more strictly speaking, to the posterior edge of the hypural bones, which is found in practical measuring by cutting the flesh away a little and probing with a steel point. For general purposes this measurement can be taken to the last scale in the lateral line.

[b] I, myself, have noted no cases in which they were absent.

soft rays is the longest, and the succeeding ones decrease gradually in size to the last, which is about one-half the length of the first.

The ventral or pelvic fins are made up of 2 spiny rays each, a long and a short one, and 8 or 9 soft rays. The height is much greater than the length at the base, but when folded back the fins do not reach as far as the beginning of the anal fin. The pectoral fins have each 1 stiff ray and 15 or 16 jointed ones, are rather elongated with rounded extremity, and reach back almost to the base of the ventrals.

The caudal fin is large, broad, and equally lobed, with the ends of the lobes rounded. The posterior notch is rounded, not very acute, and extends in half the length of the fin or less. It is made up of 18 or 19, or occasionally only 17, jointed rays, not counting the short incomplete rays (usually 4 to 6) outside the first long one on each side. The longest rays of the caudal fin are usually shorter than the head, and never exceed it in length.

The body of the typical scale carp is uniformly covered with large thick scales which approach a polygonal, four or five sided outline. In the lateral line, which extends nearly straight from the upper angle of the opercle to the middle of the base of the tail, or may be bowed slightly downward, there are 35 to 39 scales. Above the lateral line are 5 or 6 rows, and below a similar number. The scales are largest on the anterior part of the sides, where their diameter equals about one and one-half times that of the eye. Usually less than one-fourth of the scale is exposed; this portion is thicker and has a radial, fanlike ornamentation. The portion of the scale which is concealed by those in front of it is marked by fine concentric lines, which in turn form bands of varying width and regularity, and which are correlated with the growth of the scale. The middle of each scale of the lateral line is traversed by a small oblique or slightly curved tube, in which the sense organs of the lateral line are situated, and the cephalic canals of the lateral line system are noticeable on the suborbital ring.

In coloration the carp is fully as variable as in its other characters. In general the sides are yellowish, golden, or greenish, shading into a darker color on the back, which may be dark olive, or bluish-green, or almost black with a greenish cast. The yellow of the sides often becomes richer, approaching to orange on the ventral side between the anal and caudal fins. The yellow of the sides shades into whitish on the belly. The posterior edge of each scale has a dark border, and there is usually a dark blotch on the anterior part of the exposed portion, the two together forming a reticulated, or netlike pattern over the fish, with a dark spot at the anterior angle of each mesh of the net (fig. 1, pl. I). The lips are yellow or orange; the rest of the head is dark olive, except the cheeks, which are yellowish, while the under side of the head is light yellow or whitish. The iris is yellow.

The dorsal fin is olive or dark gray, each interray space being

darker in its posterior half; the rays themselves are of about the same color. The anal is yellowish-red, while the pectoral and pelvic fins are grayish or yellowish, tending to red toward their tips. The upper lobe of the caudal fin is of about the same color as the dorsal; the lower lobe has a lighter, yellowish cast, with more or less red, especially toward the end.

The coloration is influenced by the age of the fish, the character of the water in which it lives, its nutrition, the season of the year, its sexual condition, and by the other conditions of its environment. Seeley (1886, p. 97) states that unsymmetrical coloring is sometimes found and that a fish may have glittering golden stripes on one side of the body and pale steel blue on the other. Sometimes typical carp are black, bluish, green, red, golden, silvery, or even white, and Doctor Fatio records that he has kept in confinement carp which were originally green or golden, but which became colorless in an opaque vase. It is not an unusual thing to see in carp that have died out of water a reddish suffusion, especially marked in the fins, probably due to the congestion of blood in the capillaries as the circulation is stopped.

In common with the other members of the family, the mouth of the carp is without teeth, the only organs of this description being the blunt, knob-like structures lying on the pharyngeal bones in the back part of the mouth, or "throat." These are entirely for grinding food, and, as is obvious both from their position and shape, are of no use in grasping, this function being performed by the so called lips. The alimentary tract is comparatively long, but uncomplicated; the stomach is a simple tube not sharply differentiated from the esophagus and without a blind sac, while the intestine has no pyloric appendages. The entire alimentary tract from the beginning of the stomach[a] is usually two to two and one-half times as long as the body. The air bladder is large, with tough, thick walls. A transverse constriction divides it into two parts; the posterior of these is the smaller and ends in a rounded point, while the anterior portion is larger and has its base somewhat bilobed.

RACES AND VARIETIES.

The great range and frequency of variation in the carp is undoubtedly largely due to its domestication or semidomestication since early times. As is to be expected, this has resulted in the naming of a large number of varieties or races. In Europe, where carp culture is carried on systematically, these races are kept pure and true, so far as possible; but in this country no attention has been paid to them, at least in recent years, so that we need not treat them in detail here. Those interested in the subject will find an exhaustive account in the contribution entitled "Über Karpfenrassen," by Dr. Emil Walter, in

[a] The position of the thoracic septum is here taken as the beginning of the stomach.

the recent book by Knauthe (1901). These names have often been given specific value and were bestowed usually either for characters of the integument or of form (cf. Günther, 1868, p. 26); thus we have such names as *Cyprinus macrolepidotus*, *C. rex cyprinorum*, *C. specularis* (for the mirror carp), *C. nudus* (leather carp), and *C. cirrosus*, *C. regina*, *C. hungaricus*, *C. elatus*, *C. acuminatus*, etc., and *C. hybiscoides*, a variety with the fins much prolonged. This list of synonyms might be extended much further.

Hessel (1881) considers all the varieties of carp as falling into three chief groups, which he distinguishes as follows (op. cit., p. 867):[a]

1. *Cyprinus carpio communis*, the scale carp; with regular, concentrically-arranged scales, being, in fact, the original species improved.

2. *Cyprinus carpio specularis*, the mirror carp; thus named on account of the extraordinarily large scales, which run along the sides of the body in three or four rows, the rest of the body being bare.

3. *Cyprinus carpio coriaceus*, or *nudus*, the leather carp; which has on the back either only a few scales or none at all, and possesses a thick, soft skin, which feels velvety to the touch.

Walter (Knauthe, 1901), however, says the scale, mirror, and leather carp must not be considered as distinct species or races, although the conditions of the scales are characteristic, since a similar differentiation of the scales, or at least a tendency to it, is found in every true race of carp. In many ponds where one of these forms (i. e., scale, mirror, or leather) has been raised, the others have appeared spontaneously. He concludes that they should be considered only as varieties. He goes on to say that the ordinary characters are so inconstant and variable that sharp lines can not be drawn between the various intergrading races. In his opinion, the division into races should depend principally upon the relations in size of various parts or measurements of the body, though he correlates with this set of characters three others, viz, (1) rate of growth (i. e., the ability for rapid growth); (2) adaptability to climatic changes, and (3) time of sexual maturity. He then develops a rather artificial classification, depending mostly, as he says, upon the two ways in which the flesh is disposed upon the back; that is, whether there is a large development of the dorsal musculature, forming a highly arched outline, often with a hump and a reentrant angle back of the head, or whether the dorsal outline is low and comparatively straight. He uses as a measure of this the ratio of the height of the body to the length. This ratio is designated by the letter V in the following classification, translated from his paper (p. 85):

I. Cultivated races; V=1:2 to 1:3.
  - (*a*) High-backed cultivated races; V=1:2 to 1:2.6.
  - (*b*) Broad-backed cultivated races; V=1:2.61 to 1:3.

II. Primitive and degenerate races; V=1:3.01 to 1:3.6.
  Here belong also those forms under the size ratio 1:2 to 1:3 which do not have a breadth in correspondence with their size ratio.

[a] The blue carp, so called, is probably but a color phase, and not a true "variety."

It seems probable, however, that the character of the scales should be placed with the other four categories of characters given above as being another modification brought about by artificial breeding and selection and not as a condition due simply to conditions of domestication, as is sometimes supposed. All of these characters are probably heritable, although some of them, such as rate of growth and time of sexual maturity, may undoubtedly be readily influenced by external conditions in the individuals of a single generation. Furthermore, there apparently can be all combinations of these characters, and the so-called different varieties and races are the fish possessing the various combinations. In general, it may be said that the most highly specialized carp are those which are destitute of scales, which grow quickly, are high in proportion to their length, and tend to have a hump back of the head, and which become sexually mature at an early age.

These various forms of carp probably differ in no essential way, except that they are not so well differentiated and established, from what are spoken of as "breeds" by stock breeders. There would appear to be no valid reason for calling those with the different character of scales "varieties," and to class those which are differentiated as to form as "races." It is merely that the most obvious characters are those which have become most permanently established by selection, namely, character of scales first and form second. Walter claims that ability for quick growth has also been fixed in certain stocks. Thus a fish of good quick-growing stock may later make a good growth even if poorly nourished during its first or second year, whereas a fish of poor stock under similar conditions would be permanently stunted. The hardiness, or ability to resist climatic conditions, he says has not yet been made permanent in any stock, though it is claimed that scale carp possess the ability to a greater degree than the others. The adaptability to climatic conditions probably becomes reduced rather than increased as the other characters are developed.

All intermediate stages are found in the sets of characters mentioned. For example, fish may be entirely covered with scales, but the scales are larger and fewer in number than on the regular scale carp, and, similarly, one finds all gradations between the leather and the mirror carp. The same thing is true of the form of the body. This is especially the case with the fish in our waters, where all kinds have become established and have interbred until there is a complete series in the gradation of characters in almost any lot of fish taken, and a division of them into varieties must be an arbitrary one. As a matter of convenience in my work, those fish which had larger and fewer scales than typical scale carp I called mirror carp. Some authors state that the leather carp should be entirely destitute of scales; others that it may have a row of scales along the back and a row on each side. In no case in the Great Lakes did I see a carp entirely

destitute of scales, and those which are nearly bare are few compared with those entirely scaled. Of nearly 3,000 fish counted at random at various times and at different places about Lake Erie, something over 91 per cent might be called scale carp, and I should judge that at Lake St. Clair the percentage was even higher. It is very probable that under the present free conditions of life of these fish, with the constant interbreeding, they are gradually returning to the primitive scaled condition, and although there are no data to show the rate at which this process may have been progressing since they have become established in our waters, a few years more may see an even smaller proportion of mirror carp than there is at present.

HYBRIDIZATION.

Not only does the interbreeding of the different varieties of carp (using the word "variety" in its broad sense) cause confusion, but all these varieties cross readily with certain closely related species of fishes, giving rise to a number of hybrid forms. The commonest of these is a cross between the ordinary carp and the so-called crucian carp (*Carassius vulgaris*), a common fish in Europe. The resulting hybrid was described as a distinct species before its true nature was known, and was given the name *Carpio kollarii*. It is often known in Germany as the "poor man's carp." In general it is intermediate in character between its two immediate ancestors, but often resembles *Cyprinus carpio* so closely that it can be distinguished only with difficulty. Hessel (1881, p. 868) made the following experiments in crossing in order to settle the question of what resulted from the various crosses. He says:

> In order to determine this question, I myself managed to bring about such crosses by placing (1) female common carp with male crucian carp, and (2) female crucian carp with male common carp, in small tanks, constructed with this end in view; (3) I also put together female *Carpio kollarii* with male common carp; this for the sole purpose of testing the capability of propagation of the *C. kollarii*, which had been doubted. In the two former cases I obtained forms analogous to the *Carpio kollarii* sometimes approaching in appearance the true carp, at others the crucian carp. In the third case, however, having placed ripe *Carpio kollarii* together with *Cyprinus carpio*, I obtained a product with difficulty to be distinguished from the genuine carp. I took the trouble to feed them for three years, in order to try their fitness for the table, but their flesh was exceedingly poor and very bony and could not be compared by any means to that of the common carp.

Hessel remarks upon the frequency of this cross throughout Europe, and says that in many instances it is cultivated by pond owners, who suppose that they have the true carp. So far as I am aware the crucian carp has not been introduced into this country. But the carp is also said to cross readily with the gold-fish (*Carassius auratus*), tench (*Tinca tinca*), and some others. The first of these is already abundant in some of our waters, though the others have not as yet, at any rate,

become well established.[a] This is a matter of considerable importance, for whatever may be our opinion of the carp as a food fish, we certainly do not want it any poorer than it is. For this reason it would seem that efforts should be made to prevent the introduction of the crucian carp in our waters, and to restrict, so far as possible, the spread of gold-fish, tench, and other fishes with which the carp may hybridize with a resulting deterioration of the food value of the race.

SIZE, GROWTH, AND AGE.[b]

There appears to be but little definite information as to how long carp may live, and what size they may attain. It is said that they may live to be 100 or even 150 years old, and may come to weigh 80 to 90 pounds, but these statements are generally based upon insufficient evidence. That the fish do commonly reach a weight of 30 to 40 pounds, however, seems quite certain, and Hessel (1881, p. 874) says: "It is a well-known fact that two large carps, weighing from 42 to 55 pounds, were taken several years ago on one of the grand duke of Oldenburg's domains in Northern Germany," and also claims to have had in his possession some scales 2½ inches in diameter, which came from a Danube carp that weighed 67 pounds.

The largest carp I have myself seen from the Great Lakes would not weigh much over 20 pounds. That the fish do attain a much larger size is, however, certain. Mr. W. Cleaver, upon whose information I can rely, tells me that in the spring of 1903 he received from Sandusky Bay a female carp which weighed 30 pounds after spawning. According to the ratio between the weight of the ova and the entire weight of the fish found in another case, before spawning this fish would have weighed, in all probability, fully 37 pounds. From the fishermen, both at Lake St. Clair and at Lake Erie, I often heard of carp weighing 30 and 40 pounds, but these were only estimates and not based on actual figures. That there are at present to be found in these waters carp weighing more than 40 pounds I doubt.

As has already been stated, the rate of growth of carp (as is true of most fishes) depends in a great measure upon the temperature of the water in which the fish lives and the abundance of suitable food. Under ordinary conditions in open waters of temperate regions they will reach a weight of 3 to 3½ pounds in three years (Hessel, 1881, p. 873),

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[a] Goode (1888, p. 418) says the tench has become well acclimatized in the Potomac. Dr. H. M. Smith, however, informs the writer that the tench is not numerous in the Potomac, but the gold-fish is abundant and has become one of the regular market fishes at Washington. It has lost the brilliant coloration it had when it escaped from the Government ponds, and now has the dull brown color of the primitive type; the fish is not recognized in the market, and is sold under the name of "sand perch."

[b] It is maintained that the age of carp may be told with considerable accuracy by means of the successive lines of growth upon the scales, similarly to the way that the age of a tree is determined by counting the annular rings. Persons interested in this subject will find a full discussion of it by Dr. Emil Walter in the book on carp-culture by Knauthe (1901), chapter III, pp. 88-122, "Die Altersbestimmung des Karpfens nach der Schuppe."

but in warmer climates the growth is very much more rapid, and sexual maturity also is attained at an earlier age. Numerous examples of the rapid growth of carp in the warmer waters of this country have been reported. Thus in a report of the Illinois Fish Commission (Illinois, 1884, p. 10) will be found the following statement by Doctor Adams, of Spring Hill Park, Peoria, with regard to some fish received by him from the State:

At less than 2 years of age one of the carp weighed 9¾ pounds, measuring 22 inches in length, a growth of over 1 pound a month from the time it was placed in warm water.

Doctor Adams had previously had the fish in a spring where the water was cold, and they had not done well. Many more statements may be found in the early reports of the United States Fish Commission.

Goode (1888, p. 414) takes from Cholmondeley-Pennell's "Fishing" the following very good table giving the comparative weights and lengths of carp:

Length.	Weight.	Length.	Weight.	Length.	Weight.
Inches.	*Lbs. Oz.*	*Inches.*	*Lbs. Oz.*	*Inches.*	*Lbs. Oz.*
9	7¾	17	3 4½	25	10 6¾
10	11	18	3 14½	26	11 11
11	14¾	19	4 9	27	13 2
12	1 2½	20	5 5¼	28	14 10
13	1 8¼	21	6 2¾	29	15 4
14	1 14½	22	7 1½	30	16 0
15	2 4	23	8 1¾		
16	2 11½	24	9 3½		

THE COMMON NAME.

For the sake of completeness a word as to the name of the carp may not be out of place. According to Day (1880–1884, p. 159):

Carp has been derived from the Greek term "kuprinos," itself said to be from "kupris" or "Cyprus," where Aphrodite or Venus was first worshiped, and may have been given to this fish in order to symbolize its extraordinary fecundity. Holme (1688) gives *seizling* as yearlings, next a *sprole* or *sprale* from 2 years of age, terms taken from Gesner's Swiss names of this fish, they not being called "karpf" until 4 years old. In the last century we are told (Whole Art of Fishing, 1719) it was called the *fresh-water fox* and *queen of rivers*. *Cerpyn*, Welch. *De Karper*, Dutch. *La carpe*, French.

In the United States it has come to be generally known as the German carp, because of its importance in Germany and its introduction here from that country. Some protest has been made against the use of the name, as the carp is not in the strict sense a German or even a European fish, but, like the term English sparrow, it is a name that is likely to persist. Both of these names are historically appropriate, so far as we are concerned, since they serve to indicate the source of the first[a] lots of each species introduced. In ordinary usage, however, simply the word "carp" is used, and it is so that the fish is known commercially.

[a] This is leaving out of consideration the rather doubtful introduction of carp into the Hudson River from France by Captain Robinson about 1830 (see p. 540).

THE CARP IN EUROPE.

The little that is known of the early history of the carp is given, with slight variation, in nearly all works which treat of the fish, and as I have nothing to add I shall here give merely a brief summary. There seems to be a general agreement that carp were indigenous to the temperate portions of Asia; and they had probably spread into southeastern Europe before the Christian era. Aristotle speaks of it as "a river fish without a tongue, but having a fleshy roof to its mouth; as producing eggs five or six times a year, especially under the influence of the stars; as having eggs about the size of millet seed; and as being occasionally struck by the dog-star when swimming near the surface" (Houghton, 1879, p. 15). It is also mentioned by a number of other writers of early times and is spoken of as an excellent article of food.

The carp probably came into western Europe by easy stages. Hessel states that its culture in Austria can be traced back as far as the year 1227, and it is claimed to have been introduced into Germany and France two or three decades later (1258). The extensive ponds at Wittingau, in Bohemia, were begun as early as 1367. Carp culture was carried on especially in connection with monasteries and on a number of large estates, and has come to be an important commercial industry, especially in Austria-Hungary and Prussia. It is said that an acre of water suitable for carp culture will rent for as much as an acre of land. The fish's range has gradually extended in Europe, until now it is found over practically the whole of the continent from Italy to Sweden and Norway, and from France and the British Isles to Russia and the boundaries of eastern Siberia. It does not do so well, however, and is little cultivated, in the more northern portions of its range, such as Scotland, Sweden, Norway, Finland, etc.

Peyrer (1876, p. 615) states that in Austria the "Danube carp" was once a favorite and cheap food of the common people, but that its numbers have become greatly decreased. A writer (Anonymous, 1880) whose paper has been translated in the Report of the United States Fish Commission for 1878, and Veckenstedt (1880) have given good descriptions of the carp fisheries of the Peitz Lakes in Nether Lusatia, some 60 to 80 miles to the southeast of Berlin. There are some 76 of these lakes, which are a royal domain and are rented to a private individual at an annual return equivalent to $12,870. The ponds are drawn in October, and this is the occasion for a general holiday in the region. The drawing off of the water is begun three weeks beforehand, and when the fish have congregated in the deeper places they are taken by means of large drag-nets, or seines, capable of holding 5,000 pounds of fish. At Cottbus, a near-by city, meets the so-called "Carp Exchange," composed of buyers from the large firms in Halle, Leipzig, Dresden, Magdeburg, Posen, Berlin, etc. The

raisers also convene to determine the price that shall be asked for carp. It is stated that from 200,000 to 300,000 fish are sold at Cottbus in a season, representing an aggregate weight of 800,000 to 1,000,000 pounds. After being weighed the fish are transferred to perforated boats—what we would call live-cars—and are transported down the canals and rivers to the large cities, where they are to be consumed. This is a slow and laborious journey, the cars often having to be carried over shallow places on rollers, and a week is required to get the fish to Berlin, while to reach Hamburg and Madgeburg takes four or five weeks. This is in striking contrast to our method of packing the fish in ice and shipping them 500 miles or more to market in a couple of days. The German method has the advantage of getting them there alive.

Just when and whence the carp came into England is not known. It is generally conceded to have reached there, however, between 1051, when it was not mentioned in the Anglo-Saxon Dictionary of Ælfric, and 1486, the date of first publication of the "Boke of St. Albans," where it is spoken of as "a deyntous fysshe: but there ben but fewe in Englonde" (see p. 529). Linnæus puts the date of introduction into England as 1660, and it is sometimes attributed to Mascall[a] in 1514; but probably he is responsible only for the extension of the range into Sussex (Day, 1880-1884, p. 163). In the privy purse expenses of King Henry VIII, in 1532, various entries are made of rewards to persons for bringing "carpes to the king" (Yarrell, 1836, vol. i, p. 306, from Pickering's edition of Walton, p. 207, note). All recent writers agree that the oft-quoted "doggerel lines of—

> 'Turkies, carp, hop, pickerel, and beer
> Came into England all in one year'

may be considered interesting as verses, but not faithful representations of facts."

Day (1880–1884, p. 163) gives the date of the introduction of carp into Sweden as 1560[b] and into Denmark as 1660; but de Broca (1876, p. 279, footnote) says they were taken to Denmark more than a hundred years earlier, in 1550, by Pierre Oxe. Malmgren (1883), in an address to the bureau of agriculture of the imperial senate of Finland, advises against any attempt to raise carp in that country, as he thinks that on account of the climatic conditions it would not pay. They were introduced into Finland in 1861, when Chamberlain Baron v. Linder placed some in the ponds of his estate of Svartä, but they are said to have died out after a few years. Some attempts were made prior to 1861, but they were all failures. Malmgren says that Holstein and Courland are the most northerly countries where carp culture

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[a] Sometimes written "Marshall."

[b] In his "Fishes of Malabar," Day (1865, p. xii) remarks: "Block observes that in his time, 1782, owing to the degeneration of the species in the north, due to the coldness of the climate, several vessels were yearly dispatched from Prussia to Stockholm with further supplies of live carp."

is successfully carried on, and that even in Schleswig the people complain of lack of success. Nevertheless, "in 1879 a landed proprietor in Schoren [the most southerly Province of Sweden] commenced to raise carp in ponds; and there is a reasonable prospect that this kind of fish culture, if carried on rationally and cautiously, will prove profitable, because carp can easily stand the climate in the southern part of Sweden" (op. cit., p. 377). However, all attempts of King John III to raise carp on the island of Oeland proved futile.

In Norway carp were, when Malmgren wrote, acclimatized in only two places—near Farsund, in the southernmost part of the country, and at Milde, near Bergen. In Russia they were said to be found in some of the imperial ponds near St. Petersburg and near the convent of Walamo, but there was no attempt at carp culture.

These records of the northerly extension of the carp in Europe are of interest when we compare them with its distribution in North America.

INTRODUCTION AND DISTRIBUTION OF CARP IN THE UNITED STATES.

It is uncertain when the first carp were introduced into the United States. This may have been done at any time by private individuals, though if such was the case the fish were probably only kept in tanks or small ponds as curiosities, for it is certain that with the exception of their establishment in California they never gained a general distribution or attracted much attention until their successful introduction by the Fish Commission in 1877. Certain early writers mention the presence of carp in American waters, but there can be little or no doubt that they have misapplied the name to some native fish. Thus, in the Report of the Commissioners of Fisheries of Massachusetts (Massachusetts, 1866), quoting the early colonists of New England, occur the following lines in reference to the Connecticut River:

> In it swim salmon, sturgeon, carp, and eels,
> Above fly cranes, geese, ducks, herons, and teals.

And again, in his history of the Fisheries of Chesapeake Bay and its Tributaries, McDonald (1887) takes from the diary of Col. William Cabell, of "Union Hill," Nelson County, Va., the statement:

> 1769, Oct. 25: Caught 2 fine carp in our traps.

These traps were set in the James River, and in this case at least we can easily see what fish may have been mistaken for the carp, since the so-called carp-sucker (*Carpiodes cyprinus*), which in a superficial way greatly resembles the true carp, occurs abundantly in the waters of that region. A much more recent case is given by Clark (1887, p. 735), who takes from Ricketson's History of New Bedford[a] (Massachusetts) the statement following.

[a] 1858, p. 403.

In 1858 the varieties [of fishes] to be found in the waters of New Bedford were: Fresh-water: Trout, perch (white, red, yellow), pickerel, chub, carp, silverfish, minnow, hornpout, eel, clam.

But as other evidence of the occurrence of the carp in Massachusetts at that time is lacking, we must again conclude that the identification was at fault.

In 1842, however, the name of the carp appears in scientific literature, being included by De Kay (pp. 188–190) in his list of the fishes of New York. He remarks upon its introduction as follows (p. 189):

I am not aware that any attempt has been made to introduce the carp into this country previous to the year 1831, which, it will be seen by the following letter from Henry Robinson, esq., of Newburgh, Orange County [New York], was attended with complete success.

"I brought the carp from France in the years 1831 and 1832, some 2 or 3 dozen at a time, and generally lost one-third on the passage. I probably put into my ponds 6 or 7 dozen. They soon increased to a surprising degree, and I have now more than sufficient for family use. I have not paid much attention to their habits, but I have noticed that they spawn twice a year; first about the middle of May, and again in July. It is said in France that they spawn three times, but I have not observed it. During the period of spawning, which lasts about ten days, it is very amusing to watch their operations. They come up to the surface, and the females deposit their spawn along the sides of the pond among the grass, where they are impregnated by the males as they are emitted. During this process, they keep the sides of the pond in a foam with their gambols, and it is not difficult at that time to take them with your hands. They grow quickly, reaching 3 or 4 inches the first year, but after that time their growth is very slow. The largest I have taken yet have not exceeded 10 or 11 inches, my ponds being too small for them to equal the size of those you see in Europe. They are very shy of the hook; I generally bait with small pieces of fresh bread, (of which they are very fond,) made up into small pills with the fingers, and at the same time drop a small piece of bread into the water near the hook, when they bite readily. My ponds are supplied by springs of pure and clear water, but they keep the water in such a state that they cannot be seen at the bottom.

"For the last four years past, I have put from 1 to 2 dozen carp every spring in the Hudson river near my residence. They have increased so much that our fishermen frequently take them in their nets. They are larger than those in my ponds."

There are several other references in the literature to apparently the same introduction. In the Transactions of the American Institute (1851) for 1850, page 397, in a discussion before the Farmers' Club, we find the following:

Mr. Meigs.—We are pleased to see among us Captain Robinson, of Newburgh, who brought the Carp from England several years ago—thus conferring a great benefit upon his country by adding a fish before that unknown in our waters.

Captain Robinson.—I brought the Carp from France about seven[a] years ago, put them into our Hudson river, and obtained protection for them from our Legislature, which passed a law imposing a fine of $50 for destroying one of them. I put in Gold Fish at the same time. Now some of these Carps will weigh 2 pounds, and some of the Gold Fish, which are a species of Carp, are quite large, some of them being pure silvery white. Both kinds are multiplying rapidly.[b]

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[a] There is here a discrepancy in the date. If, as Robinson says in his letter to De Kay (above), he brought the carp to this country in 1831-32, seventeen years would come nearer to it than seven.

[b] This discussion is noted by E. E. Shears (1882).

From both the preceding quotations it appears that Captain Robinson had been planting young carp in the Hudson regularly since their establishment in his pond. According to a writer in Forest and Stream, who signs himself "R." (1874), these were further augmented a few years before that date by the bursting of the dams of Captain Robinson's ponds. He says:

More than fifty years ago[a] Captain Henry Robinson, owner of one of the Havre packets, brought the first carp and goldfish to this country from France. He placed them in a small pond on his place in the southern part of this village [Newburgh, N. Y.]. Several years ago, when the dam of the pond broke away, many of the fish escaped into the river. They appear to multiply very rapidly, and any number might be obtained from the fishermen about the bay.

Finally, in the Bulletin of the United States Fish Commission for 1882, we find the following letter (dated New York, May 31, 1882), to Professor Baird from Mr. Barnet Phillips (1883):

To-day Mr. James Benkard, vice-president of our fish cultural association, told me that his grandfather, Capt. Henry Robinson, had, about 1830, first brought carp from Holland [sic] and put them in his ponds at Newburg, and that he had therefore reason to suppose that the carp in the Hudson were derived from these. In Frank Forester's "Fish and Fishing," of 1849, page 166, you may find a statement to this effect, which Mr. Benkard says is substantially correct.

I have thought these data might be useful when the whole history of the carp in American waters is to be written up.

In spite of the positive statements in the foregoing quotations there still seems to be some question as to whether the true carp was found in the Hudson prior to the time of its introduction into the country by the Fish Commission. In the letter to Professor Baird from Mr. Shears (1882), dated January 26, 1881, and already quoted, he says:

I notice that the gold-fish are quite plenty in the river in this vicinity [Coxsackie, Greene County, N. Y.]; also a fish about the size and shape, which is called a silver-fish, but they do not correspond to Captain R[obinson]'s description of the silver-fish. These are nearly or quite as dark as a rock-bass. I have seen none that would weigh over one pound and a half. When caught in fykes by the fishermen, they are usually pronounced unfit to eat and thrown back in the river. However, last fall I saw them peddled through the streets, and the fishermen told me they could catch scarcely any other kind, and they sold as well as perch or bass. I have not had an opportunity to taste any of them, therefore am no judge of their flavor.

It is to be noted that he makes no mention of the carp. That Professor Baird was inclined to the opinion that there were no true carp in the Hudson is shown by the following paragraph taken from his report for 1877 (U. S. Fish Commission Report, 1879, p. *43):

Considerable discussion has arisen as to the person to whom the introduction of the carp into America is due; indeed, it is claimed that this was done many years ago. Certain fish-ponds on the Hudson River are said to have been emptied of their contents by a sudden freshet, and, as a consequence, the Hudson is now full of what

[a] Here, again, there is a discrepancy in the date. The introduction of the fish could not have been more than forty-three years before.

is called the carp and sold as such in the New York market. I have not yet, however, been able to find a single fish among those sold as carp which is really any other than the common gold-fish, reverted to its original normal condition. Indeed, in the olivaceous fish caught in great numbers in the Hudson there are usually found precisely similar specimens of white, red, and all intermediate conditions. While, therefore, I can not say that no genuine carp were transferred to the Hudson, none have come under my observation; and it has occurred to me as possible that the Prussian carp, *Cyprinus carassius*, L., may have been the one introduced, or possibly the hybrid progeny of this and the true carp may have been gradually mixed with the gold-fish.

If we could know whether the description given by De Kay (1842, p. 188) was made by him from specimens taken in New York, or whether he merely copied what he gives from some European writer, we might be able to throw some light on this subject. Certain it is that his description disagrees in a number of points with that of the true *Cyprinus carpio*, but it is apparent that some of these are inaccuracies, as they do not agree either with the Prussian (or crucian) carp or with the hybrid, the so-called *Cyprinus kollarii*. The most important points in this connection are, perhaps, that he gives the length as 6 to 12 inches, and describes the "nape and back" as "rising suddenly." True carp in the second or third year, under ordinary conditions, should attain a length of more than 6 to 12 inches, while the hybrid rarely exceeds 8 inches in length (Seeley, 1886, p. 104). It is noteworthy, too, that Captain Robinson in his letter to De Kay (p. 540) states that his fish grew quickly, reaching 3 or 4 inches the first year, but after that time their growth was very slow, while the largest he had taken from his pond did not exceed 10 or 11 inches. He adds, however, that those subsequently taken from the river were larger than those in his ponds.

Even more significant, it seems to me, however, is the statement that the nape and back rise suddenly, for though this may be in some of the more highly cultivated races of carp, it is not usually the case, especially when they have bred out of the confinement of ponds for a time, where no artificial selection is made. On the other hand, the description forcibly suggests the broad shape of the hybrid mentioned, which in outline approaches the crucian or Prussian carp, *Carassius vulgaris*. That this last is not the fish meant by De Kay is shown by his statement that the fish has four barbels.

As matters stand, we shall probably never know whether the fish brought over by Captain Robinson were true carp or whether he happened when procuring the fish in France to get hold of specimens of the hybrid form, which occurs in abundance in many parts of Europe. It makes little difference which they were, however, since the comparatively little stock in the fresh waters of southeastern New York could have little influence on the multitude of fish, from a new importation, which was spread broadcast over the country a few years later.

The circumstances attending the successful introduction of the scale carp into California, in 1872, by Mr. J. A. Poppe, of Sonoma, are better known. Mr. Poppe left California for Germany in the spring of 1872. At a place called Reinfeld, in Holstein, he procured 83 carp of various ages and sizes (cf. Poppe, R. A., 1880, p. 663), the three largest of which were 2 feet or more in length, the smallest "the length of an ordinary steel pen." The fish were placed in 22-gallon tanks arranged one above the other, so that the water flowed down from the highest to the lowest, when it was dipped back to the top. These were put aboard a steamer for New York. Many of the carp died on the way, the larger ones going first, and only 8 reached New York alive. These were taken across the continent to San Francisco in safety, but 3 more were lost before reaching Sonoma, where Mr. Poppe arrived on the 5th of August, 1872, with only 5 of the smallest of the 83 fish with which he started. Ponds had already been prepared, and the surviving carp were placed in them at once. They did well from the first, and, according to Mr. Poppe in the report mentioned above, they spawned the next spring, by which time they had reached a length of 16 inches! It was estimated that in May (1873) there were in the ponds over 3,000 young carp. The young fish were sold to farmers throughout California and adjacent states, and some were shipped even to Honolulu and Central America. The report gives a list of persons in Sonoma County who undertook the culture of the fish, and states that at that time (presumably 1878) Los Angeles, San Bernardino, and the adjacent counties in the southern part of the state were well supplied with the fish, and reports were coming in from all quarters that they were doing remarkably well.

There seems to be some question, also, as to whether the fish introduced by Mr. Poppe were a pure strain, for Professor Baird (U. S. Fish Commission Report, 1879, p. *44), who examined some specimens that were sent to him, says:

> These are scale carp, apparently somewhat hybridized; at least, they do not present the characteristics of the pure breed brought by Mr. Hessel:[a]

He here refers to the fish introduced under the direction of the Fish Commission, the subject which we will now consider.

The question of the introduction of the carp into the United States was taken up by the Fish Commission within a few years after the organization of that Bureau. The first mention of it occurs in the report for the years 1872 and 1873 (U. S. Fish Commission Report, 1874, pp. lxxvi, lxxvii) under "Fishes especially worthy of cultivation." Professor Baird, at that time Commissioner, there says:

> Sufficient attention has not been paid in the United States to the introduction of the European carp as a food-fish, and yet it is quite safe to say that there is no other

[a] Goode (1888, p. 417) says: "Those [carp] introduced into California a few years ago by Mr. Popp were an inferior strain of Scale Carp."

species that promises so great a return in limited waters. It has the pre-eminent advantage over such fish as the black bass, trout, grayling, &c., that it is a vegetable feeder, and, although not disdaining animal matters, can thrive very well upon aquatic vegetation alone. On this account it can be kept in tanks, small ponds, &c., and a very much larger weight obtained, without expense, than in the case of the other kinds indicated.

It is on this account that its culture has been continued for centuries. It is also a mistake to compare the flesh with that of the ordinary *Cyprinidæ* of the United States, such as suckers, chubs, and the like, the flesh of the genuine carp (*Cyprinus carpio*) being firm, flaky, and in some varieties almost equal to the European trout.

It was not the intention of the Fish Commission to introduce the carp into waters that were already stocked with good native species, nor was it claimed that the carp was superior to the majority of our indigenous food fish. But it was believed that it could be successfully raised in many sections of our country not favorable to the growth of better fish. In this connection Professor Baird remarks in a subsequent report (U. S. Fish Commission Report, 1879, p. *41):

There are several species of American *Catostomidæ* which might in all probability answer in some measure, if not fully, in place of the carp. Among them are especially the buffalo fish, a large sucker, the flesh of which is much esteemed. As, however, some special varieties of carp have been developed and had their instinct of domestication established, while experiments on our indigenous species are scarcely yet tried, there is no reason why time should be lost with the less proved species.

In another place (U. S. Fish Commission Report 1873–4 and 1874–5, p. xxxvi) he enumerates the good qualities of the carp which made it a desirable species for cultural purposes in the United States. These are given as follows:

1. Fecundity and adaptability to the processes of artificial propagation.
2. Living largely on a vegetable diet.
3. Hardiness in all stages of growth.
4. Adaptability to conditions unfavorable to any equally palatable American fish and to very varied climates.
5. Rapid growth.
6. Harmlessness in its relation to other fishes.
7. Ability to populate waters to their greatest extent.
8. Good table qualities.

Nearly all, if not all, of our American food fishes are carnivorous, preying for the most part upon smaller fish of all kinds. The increase of these forms is therefore necessarily limited, especially in small bodies of water, where it is difficult to keep them supplied with food. The large-mouthed black bass (*Micropterus salmoides*), which has been extensively used for stocking rivers and lakes throughout the country, is a good example. But where strictly a food fish was required, it seemed that one at least in large part a vegetable feeder possessed far greater advantages, and, as stated above, no native fish answered these requirements so well as the carp.

In the winter of 1876–77, Mr. Rudolph Hessel, in the interests of the Fish Commission, as an initial experiment shipped carp from

Bremen to Baltimore, but, owing to a storm of unusual severity to which the vessel was exposed, all were lost on the way. He immediately returned to Europe, however, where, at Höchst, near Frankfurt, he procured another lot of fish. These he succeeded in bringing in safety to New York, and on May 26, 1877, they were placed in ponds in Druid Hill Park, Baltimore. This lot consisted of 345 fish, of which 227 were naked and mirror carp, and 118 were common scale carp. The ponds at Druid Hill Park not being sufficient for the proper care of the fish, Congress allowed use to be made of the Babcock Lakes in the Monument lot, in the city of Washington, and appropriated the sum of $5,000 to put these in proper condition. In the following spring these ponds were ready for the reception of the fish, and 65 leather carp and 48 scale carp were transferred to them from the Druid Hill Park ponds.

The fish that remained in Baltimore, under the care of Mr. T. B. Ferguson, spawned in 1878, but some gold-fish had entered the pond accidentally, and the carp hybridized with these, so that instead of having young true carp there were some 2,000 hybrid young. These were destroyed as being worthless. The results were more satisfactory in 1879, in which year about 6,000 young were reared. Of these, 2,750 were distributed to applicants throughout Maryland, the remainder in other states. In this year the fish in the ponds at Washington spawned for the first time, and about 6,000 were also reared there. Altogether, in 1879, some 12,265 carp were distributed to over 300 persons in 25 states and territories. Among the recipients were various state commissioners, who redistributed their fish to applicants in their respective states.

Applications for carp had begun to come in as early as the fall of 1876, and the number increased rapidly in the succeeding years. In 1877 there were 22 applications, in 1878 144, and in 1879 235, while in 1880 there were nearly 2,000.

In 1879 new ponds were constructed at Druid Hill Park, and it was in this year, also, that a new importation of carp was made from Germany. These were brought over by Dr. O. Finsch (1882), a German naturalist, who obtained 100 mirror carp from Mr. Eckhardt, of Lübbinchen. These were small fish, a year and a half old and only 6 to 8 inches long. Only 23 reached New York alive, although the water was aerated by pumping air into it, and ice was used to keep the temperature down. The fish were shipped from Hamburg in coal-oil barrels, and Dr. Finsch attributes the large mortality to the fact that one of the barrels was not clean, and to the warm weather. The survivors arrived in New York on the 6th of May, whence they were shipped to Washington without loss and turned over to Mr. Hessel, the superintendent of the Washington ponds.

In the succeeding years the demand for carp steadily increased, and the fish were furnished in great numbers by the Fish Commission, being sent to all parts of the United States, and some shipments being made to other countries. We find in the reports of the Commission that in several successive years carp were sent to Canada, and in 1882[a] they were also distributed to persons in Ecuador, Costa Rica, and the City of Mexico. In 1882 over 7,000 applications for carp were filed, and 5,758 applicants were supplied with 15 to 20 carp each, 143,696 fish being distributed in this way. With an appropriation of $12,000 made by the Forty-sixth Congress, the breeding ponds were extended until there were some 20 acres of ponds devoted to raising this fish.

In this year, also, an attempt was made to bring carp eggs to this country. On May 31, Mr. George Eckhardt arrived from Germany with two cases of carp eggs, packed after a method that had been found successful for transportation for shorter distances; but when the eggs were examined here they were found to be dead and covered with fungus. The effort had been made only as an experiment, and was so far unsuccessful, on account of the long time required for the journey, that it was not repeated. Another importation of the adult fish, however, is recorded in 1882, when, as a return for favors extended to the Deutsche Fischerei-Verein, Herr von Behr forwarded to the Commission a number of the so-called blue carp, "a variety believed to be of particular interest, and which has not been hitherto cultivated by the Commission." When these arrived on January 4, 1882, it was found that 19 of them were of "pure blood," while 4 were hybrids. The hybrids were destroyed and the others turned into the Government ponds.

As illustrating how thoroughly carp were disseminated throughout the United States in these early years of its introduction, the data for 1883 furnish an interesting example. In that year carp were sent into 298 of the 301 Congressional districts, representing 1,478 counties; in this way 260,000 carp were distributed, in lots of 20, to 9,872 applicants. The distributions continued large until about 1890, when they began to diminish, and were finally discontinued in 1897. The following table gives the approximate figures for the distribution from 1880 to 1896:

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[a] Records taken from United States Fish Commission reports have reference to fiscal years beginning July 1. Distributions of carp were made in the fall of the calendar year preceding the date designating the fiscal year—i. e., distributions in the fiscal year 1882 were made in the fall of the calendar year 1881.

Carp distributed by the United States Fish Commission.

Fiscal year.	Number of fish.	Fiscal year.	Number of fish.
1880	12,265	1889	170,402
1881	66,165	1890	26,316
1882	143,696	1891	338,809
1883	259,188	1892	157,093
1884	162,000	1893	72,481
1885	167,948	1894 [a]	47,757
1886	348,784	1895	33,935
1887	133,769	1896 [b]	87,203
1888	175,410		

[a] In 1894 400,000 young carp were used for feeding bass.

[b] In 1896 about 600,000 young carp were used for feeding bass, and since that date all the carp hatched by the Government have been used for the same purpose.

At the present time the carp has come to have a very general distribution, especially in the temperate portions of the world. Its distribution in Asia and Europe has already been mentioned (p. 537). It is now found in abundance all over the United States wherever the waters are at all suitable. Many were sent to Canada by this Government shortly after the introduction of the species, but with the exception of some of the waters of Ontario, especially in the vicinity of the Great Lakes, it does not appear to have become very abundant, owing without doubt to the coldness of the waters. From this country a number of lots were sent to Ecuador, Costa Rica, and Mexico, where it was said to be thriving. It was introduced into the Hawaiian Islands from California, and Cobb (1902, p. 452) reports it as being found now on the islands of Maui and Kauai. On the former it is quite common in the irrigation ditches near Wailuku, where it is said to have been first planted. The fish are not often sold, as they are not popular with the whites and natives on account of their muddy flavor, but they are caught and eaten by the Japanese and Chinese.

In reference more particularly to the history of the carp in the Great Lakes region, there can be little doubt that prior to 1879 there were no carp here. In that year the first distribution was made by the United States Fish Commission, and those who received fish were 6 applicants in Ohio, 5 in Indiana, 2 in Illinois, and 1 in Wisconsin. In the following year a large number of persons in these states received carp either directly from the United States Commission or indirectly through their state commissions, and the real introduction of this fish into the waters of the Great Lakes basin may be said to date practically from that year. This was only twenty-five years ago, and the wonderful increase of carp since that time is in many ways comparable to that of the English sparrow in this country.

The distribution of carp in 1880 did not take place until late in the year—in November for the most part—and it is not likely that many reached the public waters that fall. Many of them surely did so the following season, however, to say nothing of those that were planted

there directly by the government and state commissions. There was at this time a fever of enthusiasm for carp culture throughout all parts of the United States. From the time of the proposed introduction the Fish Commission had published many papers, including a number of translations of German articles, giving much information on the habits of the carp and its desirable qualities, and explicit directions as to the methods in vogue in raising carp in Germany, where this industry is most important. The newspapers took the matter up and were loud in its praises, but neglected to give so large a share of attention to the practical side of the question—to the care and attention the fish should have in order to make the venture a success. Most men are interested at once when they think there is a chance of getting something for nothing, and here seemed to be an opportunity to have a perpetual supply of fresh fish for anyone who had land with any kind of a mud hole on it that would hold a few bucketfuls of water. Accordingly applications for carp piled in, and were filled as soon as possible. As a result of ignorance and neglect, a large proportion of these fish or their offspring were soon undoubtedly in the public waters—largely from the breaking of dams of improperly constructed ponds, and two years later (in 1883) came reports of their being taken in considerable numbers by fishermen in the rivers and lakes.

Besides the stocking of the public waters which occurred accidentally, many fish were also purposely planted in them. In 1881 the Ohio State Fish Commission put 40 carp into the Maumee River (Ohio Fish Commission Report, 1882, p. 1435), and in May of the same year some were planted in Ten Mile Creek. These were 2½ inches long when liberated, and it is reported that in the following September and October a number were caught which would weigh 4½ to 5 pounds, while one had a weight of 8 pounds. In the same report we read that 12 carp were given to Mr. Charles Carpenter, of Kelleys Island, which is in the very midst of the breeding grounds of the white-fish, and 17 to Mr. Edward Lockwood, on the (Catawba) Peninsula. Both of these lots doubtless contributed sooner or later to stock the lake. Indeed, one of the first lots of carp sent out from Washington was in November, 1879, to Mr. Lewis Leppelman, Fremont, Ohio (Smiley, 1886, p. 792), which is on the Sandusky River, and probably there is no place in the United States to-day where carp are much more abundant than in the waters of Sandusky River and Bay. In July, 1883, however, Mr. Leppelman thought he still had all his fish, so they could not have contributed to the first stocking of the river and lake.

One of the earliest records I find of the taking of carp in Lake Erie, where they are now so abundant, is given in a compilation by Mr. C. W. Smiley (1886, p. 738) among the statements of those who received carp of the Fish Commission. This is the statement of J. C. Sterling, of Monroe, Mich., December 10, 1883, that one of the

Monroe fishermen found in his catch of white-fish the previous week a fine specimen of German carp which weighed 3¾ pounds. The pound from which the fish was taken was in Lake Erie, about three-fourths of a mile out from the mouth of Raisin River. I was unable to learn from the fishermen of this region the exact year when they began to catch carp, but all agreed that it was "in the early eighties." I was told that when the first carp were taken no one about the fish houses knew what they were, and they were kept on exhibition in tubs as curiosities. It is needless to say that they are no curiosity there now, when hundreds of tons are shipped from a single place in the course of a year.

About this same time carp began to be taken by the fishermen in the waters of the Mississippi River and its tributaries. Early in July, 1883, a fisherman at Naples, Ill., on the Illinois River, caught a mirror carp weighing 5 pounds. At Pekin a mirror carp was taken which weighed 6 pounds, and at Meredosia, also on the Illinois River, another, with a weight of 8 pounds (Illinois Fish Commission Report for 1883, pp. 10–12). Carp which had escaped from ponds were also taken at or near Hannibal, on the Mississippi, and young carp were taken at Quincy. Their numbers have increased to a remarkable extent, until now the carp forms the most important fishery product of Illinois.

The Great Lakes are, on the whole, not well suited to carp. Their sandy or rocky bottoms near shore are hard and wave beaten, and support at the best a very scanty vegetation, while they slope off so quickly to a considerable depth that the sun has little chance to raise the temperature of the shallow water to that degree of warmth most favorable for these fish. The western end of Lake Erie and Lake St. Clair, especially at its upper end, on the broad delta formed by the St. Clair River and known as the St. Clair Flats, are exceptions. In the latter place the shallow bays often possess soft, muddy bottoms, and are filled with animal and plant life similar to that found in the smaller inland lakes. These conditions suit the carp well, and it is found there in great abundance. Even better are the conditions in Lake Erie, for the whole upper end of the lake is of inconsiderable depth, while into it open rivers and bays with hundreds of square miles of flat, muddy, reed-grown marshes, which furnish ideal feeding and breeding grounds for a fish like the carp. It is probable that the fish breed, for the most part at least, in the marshes; but they are often fully as abundant in the lake itself. Just what relation they have to the two places—to the marshes and to the open lake—has not been definitely determined, but the probability of their migration from one to the other, with possibly more or less regularity, will be discussed later.

The most extensive marshes connecting with Lake Erie are those of Sandusky Bay and Sandusky River, which opens into it, the marshes

along the Portage River above Port Clinton, at Monroe, Mich., and at places along the north shore. These last I have never had opportunity to visit. Marshes of less extent occur at Erie, Pa., and at other places along the south shore.

It must not be supposed from what has been said that the carp are by any means limited to the places mentioned in Lake Erie and Lake St. Clair and in the waters of the Mississippi River and its tributaries. As a matter of fact they are usually present in numbers in any of the inland lakes and streams of the region which are suitable for them, and especially near the mouths of many of the rivers emptying into the Great Lakes, which usually have more or less extensive marshes for some distance back. This is true of nearly all the streams which open into the lower end of Lake Huron, Lake St. Clair, and Lake Erie, and into the St. Clair and Detroit rivers, connecting them. It is due to a slight tilting of the earth's crust to the southeast, which has caused the waters to flood the lower courses of the streams and produce what are known as "drowned channels." The marshes along the western side of Michigan are probably due for the most part to a simpler cause. There the sand, which is thrown up by the waves and has been blown up into immense dunes, tends to choke up the mouths of the streams entering Lake Michigan, causing them to flood the country many miles back. Such marshes are found along the Kalamazoo, Black, and Grand rivers, and at Muskegon and other places along the lake, in all of which carp are plentiful.

That the extensive carp fisheries are at present confined to so few localities results from a number of causes, among which is not so much the relative abundance of the fish as the ease with which it may be taken. The shallow shores of Lake Erie and the equally shallow bays of the St. Clair flats afford excellent places for hauling a seine—an operation which is often attended with great difficulty or is well nigh impossible in the marshes, where the bottom is soft and the water grown with weeds. Local laws also, in some places, interfere with the seining of carp.

HABITS AND SPECIAL SENSES OF THE CARP.

Observing wild carp under natural conditions requires much care and a great deal of patience. Under favorable circumstances, when not disturbed or alarmed, they may often be seen swimming lazily about among the weeds in shallow water, frequently with the dorsal fin projecting above the surface. Their mouths are constantly in motion as they breathe, taking in water and expelling it through the gills, and at the same time working about in the mud or over the surfaces of the water plants for food. The resemblance of their mouths to that of the sucker is at such times especially apparent. In spite of the appearance of taking life so easily, they have nevertheless the

ability for quick and powerful movement, for, let anything give the fish the least fright, there is a twirl, a splash, and it is gone. It is, in fact, a strong and rapid swimmer when it puts forth the effort. One who has occasion to search for carp comes to be able to recognize them almost without fail just by the way they make this sudden break and dash away, even if the water is so roily—as is often the case—that the fish can not be seen at all. If the water is more than a foot or so in depth, there is usually not a splash, although there is an audible sound, a sort of dull thud; the water boils up where the fish started with the first strong lash of its tail, and a disturbance of the water due to the rapid passage of the fleeing fish underneath shows the course as it dashes away. This it usually does in an almost straight line—that is, it does not zigzag about. If the water is clear, a glimpse of the fish may be caught; or, if among rushes or cat-tail flags, the movement of these indicates the line of retreat. If a considerable school of large carp is startled, and they go off in this way through the rushes, the whole surrounding growth will wave and rattle as if a sudden and erratic wind had struck it, the reeds twisting and bending in all directions at once. There are other fish, such as the fresh-water dog-fish (*Amia calva*) and some of the bass, which one will sometimes start up singly here and there among the rushes, and which will dart suddenly away; but anyone who ever chances to startle a school of carp in this way will have no trouble guessing the authors, if, indeed, it occurs to him to attribute so much commotion to fish at all.

This refers to carp in the open. In ponds they become easily tamed, learn to come to a certain spot to be fed, and, it is said, will even take food from the hand. This tameness in small ponds probably depends not only upon the familiarity the fish come to have with the surroundings and with people, but as well upon the fact that they are better fed and the struggle for existence is greatly reduced—their common enemies are absent, so that they get less exercise and tend to become more sluggish in temperament. To prevent this, it is the custom of European fish culturists to introduce into their ponds certain predaceous fish, such as pike, which keep the carp active and in good condition.

That carp are wary is well known to fishermen, who speak of them as "wise," "knowing," and "cunning." For this reason their capture is difficult. They usually avoid the ordinary form of set net, so that comparatively few are taken in fykes, traps, or pounds. Seines, once around them, are difficult to evade, and it is in this way that they are taken for the most part. But if a seine becomes torn or does not drag closely on the bottom they are quick to find the opening, while large numbers often escape by jumping out of water and clearing the cork line. Day speaks of this characteristic of the carp in his work on the

Fishes of Great Britain and Ireland (1880–1884, p. 160). To use his words:

> The fisherman finds this fish an adept at escaping from nets, by burrowing below it, or springing over the corks, . . . So difficult is it to net that . . . one can well understand the Norfolk pen-men regarding it with mysterious awe, how its entrances and its exits into pieces of water puzzle them, and how, as Lubbock remarks, they consider it as something more than a fish, and look upon it as what the Scotch term "no cannie."

Although I have spoken above of the carp's habit of ordinarily swimming about lazily and quietly, this is by no means always the case, for these fish often produce a considerable disturbance by their splashing. This is when they are feeding in shallow water, and will be discussed more fully when we come to consider the feeding habits. They also splash about considerably at the breeding time.

Carp exhibit a marked tendency to go about in schools. In regions where they are abundant, it is usual to find either a large number in a given locality, or else none at all. That these schools are frequently of great size is apparent from the fact that several tons of carp are often taken at a single seine-haul along the shore of the open lake, which is rather more conclusive evidence than is afforded when they are taken in a bay or other partially inclosed place.

Moderately warm, shallow waters with abundance of aquatic vegetation, and deeper places to which the fish can retreat, are the most favorable conditions for carp, and it is in such places that they multiply fastest and obtain their most rapid growth. In the hilly eastern part of the United States localities of this kind are relatively scarce, but the rivers and lakes of the Southern and Middle States, with their extensive bayous and marshes, come very close to the ideal conditions. This suitability is abundantly evidenced by the rapidity with which carp have taken possession of them, and have become in them, it might almost be said, the dominant piscine type. Nevertheless they are by no means confined to these waters which meet their requirements to the best advantage, but seem to be able to adapt themselves to a variety of conditions, though with less success. Thus we find them invading to a certain extent the colder and deeper waters of the Great Lakes, though a few fathoms is a great depth for them, and I have no evidence to show that they go to any extent into the deeper waters. They will live in small ponds fed by springs, where the temperature of the water always remains very low, but in such places their growth is slow and they are by no means so prolific as in warmer waters. On the other hand, they may sometimes be found living in mudholes, where it would not seem that they could obtain enough food for existence and where the temperature must at times in summer become comparatively high. They will live, and apparently do well, in waters that are strongly mineral. I saw, for example, a carp pond in northern Ohio

fed by an artesian well so heavily charged with sulphur that what appeared to be free sulphur was deposited in the wooden trough which conducted the water from the pipe to the pond. It is said that they even occur in abundance in the brackish or semibrackish waters of the Atlantic coastal region (Townsend, in "Discussion on Carp," Transactions American Fisheries Society for 1901, p. 117); and Day (1880–1884, p. 163) states that "a considerable number are taken in the Black Sea and Caspian; and Nordmann remarks upon their presence in the salt lakes of New Russia."

SIGHT.

Although carp work about in muddy, roily water, the roiliness being due largely to their method of feeding, they have, nevertheless, a quick sight, which serves them well when the water is clear. As will be discussed more fully under the subject of hearing, many actions which have been attributed to that sense are in reality dependent upon sight. Not only do they take fright easily at anything which moves, but there can be no doubt that they are able to recognize unusual stationary objects as well. I have often stood quietly for long times where the water was clear and carp were feeding on all sides of me only a short distance away. But when a fish came in my direction, it seldom approached closer than seven or eight feet, and usually not so close, before it would take fright and dash suddenly off. On the other hand, I have sometimes stood in roily water when they would actually bump into my legs before they would turn with a splash and dart away. At one time I built a scaffold some seven feet high above water in order to be able to overlook a wider circle of marsh. It was on the edge of a large spawning ground of black bass, and although a bass which was guarding a nest not far from the base of the scaffold soon became accustomed to the unusual structure and resumed his domestic duties, few carp came in sight, in spite of the fact that I sometimes remained quietly there for an hour and more at a time. When they came within a circle which would be traced by a line at an angle of approximately 45° from my position to the water, they apparently became frightened, and left suddenly.

In attempting to study the behavior of the fish at night, I at another time employed a powerful acetylene searchlight, such as is manufactured for use on launches. But this seemed to frighten them, even when 4 or 5 rods away. As the beam of light was swept around to different points I could hear the carp dash away through the rushes, and could sometimes see the disturbance they caused in the water, but in no case was I able to get close enough to see the fish themselves. Common experience in fishing at night with a "jack" shows that many kinds of fish are not so frightened by a sudden strong light.

That sight plays an important part in the feeding of carp may

readily be seen by the way they sometimes immediately take food thrown into the water before it has a chance to settle to the bottom. I have made no experiments to test accurately the sense of sight in carp.

HEARING.

It has always been a widespread opinion among carp culturists and fishermen that these fish are quick to detect and respond to ordinary sounds, such, for example, as the human voice. It is well known that pond fish regularly fed at a particular place soon learn to congregate at that place to receive their food. Many such instances have been recorded not only for carp, but for gold-fish, trout, and other species. As an illustration of the popular belief, which was apparently as prevalent in this country as in Europe, I may quote the statement of Mr. S. W. Coffin, given by Smiley (1886, p. 696):

> The sound of my voice is sufficient to bring them to the surface of the water, and a whistle causes them to come for food. For this they scamper through the water like so many pigs. They disappear as suddenly at the voice of a stranger.

Seeley (1886, p. 98) says:

> The hearing of the carp is excellent, and there are many examples of their answering a call; and it moves by hearing even when it cannot see. It makes an audible sound in eating and in swallowing air.

Fishermen, both here and abroad, are very careful to make as little noise as possible as they set their nets around a school of carp in the open or prepare to seine them from a pond; but when the net is set and it is desired to drive the fish into it they splash the water and shout to make all the noise they can.

Parker (1903) has recently investigated this sense in a few fishes and has given a general discussion of the subject. Since then Bigelow (1904) has done the same for the gold-fish; and since this last is such a near relative of the carp, we may be reasonably certain that the conditions in the two species are much the same. The experiments of these authors show without doubt that certain fishes, including the gold-fish, and so we are safe in assuming also the carp, are capable of hearing sounds produced in the water, or which are transmitted directly to the water, such as striking the side of a boat with an oar. I have had opportunity to see evidence of this in the field myself. By paddling quietly and carefully I have been able to work my boat into an open area in a pond where carp were present in numbers without disturbing a fish, when a sharp blow against the rail of the boat with the paddle would send them scurrying into the rushes in all directions. In this case, however, other vibrations besides sound waves are transmitted to the water which the fish might perceive by the sense of touch, so that such an experiment could not be considered as conclusive evidence that the fish heard the sound. This complication was obviated in the experiments of the authors mentioned above by the

use of an electric tuning fork giving a certain number of vibrations per second, which was placed against a board end of the aquarium in which the fish were being tested.

On the other hand, most fish "appear to be unaffected by loud talking or other like noises originating in the air" (Parker, 1903, p. 45), due undoubtedly to the fact that the ordinary sound waves produced in the air are transmitted to the water to a very slight extent at most. Several years earlier Kreidl (1896) had performed certain experiments on trout in the fish basins of the Benedictine Monastery at Krems, Austria, where the fish were called up to be fed at the ringing of a bell. He found that the fish appeared just the same if a person went to the customary place without ringing the bell, and that no amount of bell ringing would bring them if the person remained out of sight. On this account Kreidl concluded that fish could not hear at all. That sight is the important factor in the assembling of gold-fish to be fed was suggested by Seeley (1886) some ten years before, though he credited them with the ability to hear as well. He says (p. 112):

> Their sense of sound is sufficiently acute to obey a familiar call. The Chinese are said to assemble them in ponds at feeding-time in this way; but in ponds where visitors feed them in Europe they presumably detect the newcomer by sight; for we have noticed that a gathering never fails to greet visitors on their appearance at public gardens in which these fishes are exhibited.

From all this it appears that while fishermen, when desiring not to frighten the fish, need to be careful not to make disturbances which are transmitted directly to the water, such as splashing, or jarring a boat or similar object partially submerged, they need have little fear of talking; while, conversely, shouting probably has as little effect in helping to drive the fish, when that is the result desired. This fact will probably be received with satisfaction by those anglers who believed it necessary, but found it onerous, to maintain a sphinxlike silence while trying to outwit their finny prey.

TASTE AND SMELL.

As a matter of convenience these senses will be considered together. Of the two in fishes the former is much the better understood. Herrick (1903) has recently made an important contribution to the subject, besides giving an excellent review of the literature. It has long been known that carp have sense organs, known as "terminal buds," over the whole surface of the body and on the barbels, similar to those which occur abundantly in the mouth, and to which the sense of taste has rightly been assigned. Direct physiological experiments have not been made on carp, but from his experiments on a large series of other fishes Herrick concludes (p. 266) that—

> It may be regarded as established that fishes which possess terminal buds in the outer skin taste by means of these organs and habitually find their food by their means, while fishes which lack these organs in the skin have the sense of taste confined to the mouth.

Terminal buds, or taste-buds, outside the mouth are best developed in bottom-feeding forms and those which, like the carp, burrow into the mud for their food. They probably enable a carp to determine the presence of food material in the mud without actually having to take the mud into the mouth to test it.

What part the sense of smell plays is not so well established, though from the experiments that have been made on other fishes it would appear to be of minor importance and to be of little value in a directive way in the finding of food. In many fishes, however, it appears to enable them to detect the presence of food when it is in the immediate vicinity.

The tactile sense is well developed. How far carp can detect slight movements of the water, a faculty attributed by Parker (1903) to the lateral line, has not been determined.

MIGRATIONS.

The word migration is not used here in the strict sense of a regular and stated movement from one place to another, such as occurs in the salmon, shad, suckers, and many other species that ascend rivers and streams to spawn. The only habit of the carp which can be compared to this is their retreat to deeper water with cold weather and their return to shallower water with the coming of spring. Their movements at other seasons appear to be irregular and probably depend upon local and variable conditions. In ponds and other small bodies of water such migrations are necessarily limited, but may be much more extended and noticeable in large bodies of water such as the Great Lakes.

Some attempt was made to study this question in Lake Erie and the adjacent waters by liberating tagged fish and distributing a circular among the fishermen and fish dealers of the region, asking for the records of any of these fish that might be recaptured. A small copper tag bearing a number was attached, usually to the strong spine of the dorsal fin, by a piece of copper wire, though in a few cases the wire was passed through the basal lobe of one of the pectoral fins. This work was attempted only on a small scale at first, and later opportunity did not offer for giving it a more effective trial. Moreover, the method in which the carp are handled by the fishermen and in the wholesale houses made it very unlikely that the small tags would be noticed before the fish reached the retail dealers in far away cities, when it would be too late to get the desired data, even if the tags were returned. As it was, only about one hundred individuals were tagged and liberated, mostly in the vicinity of Port Clinton and Sandusky, and none of these was ever heard from again. As a consequence, direct observation and the results and testimony of the fishermen had to be relied upon for what information on this subject they

would give, and as the evidence gathered in this way was rather meager the question is still far from settled. Some of the observations are of much interest, however, and may serve to throw a little light on the subject.

A large proportion of the carp shipped from northwestern Ohio and southeastern Michigan are taken directly from Lake Erie. Many fishermen are engaged in the business, and they, for practical purposes, have had to learn much about the habits of the fish which furnishes them their livelihood. They go to the fishing grounds usually in open sail boats, returning to market when they have secured a good haul of fish. This means only a day's, or possibly two days', fishing when the carp are "on," but under unfavorable conditions the boats are often gone a week or more. The fish are taken for the most part by means of seines in shallow waters along shores. The methods of seining will be described more fully later (p. 611).

It is not surpising, in a body of water the size of Lake Erie, that storms should affect very largely, in fact we might almost say control entirely, the abundance of carp along the shore. According to the government chart, there is nowhere in the upper end of the lake more than six fathoms of water, while along the southern side water less than three fathoms deep extends to a distance of two to five miles off shore. Strong northwesterly winds are not infrequent during the summer months, and in the winter the principal storms are from the north and northeast. It does not take very high winds to stir such shallow waters to their depths, as is shown by the fact that even in moderate storms the water is made roily to a long distance off shore. At such times the carp apparently go out to the deeper waters, and the fisherman say they do not come in again until a day or two after the storm. Unfortunately the only data we have for determining the extent and character of these movements are the occurrences in the shallow shore water; we have little or no data for telling where the fish go when they leave. Pound nets in the vicinity of Niagara Reef, which is seven miles from the nearest land, and which were kept in operation all summer by a Port Clinton firm, did not help to throw any light on this question, since few carp were taken in them at any time. It is possible that during storms some of the carp leave the lake and run up the bays and rivers, and I am not convinced that such is not the case, at least with easterly storms, which raise the water level very appreciably at the western end of the lake. This produces a backward current up the bays and rivers, and evidence will be brought forward to show that carp run up the rivers with this back set. But storms from the north do not have this effect, while westerly winds lower the water rather than raise it. So while I think it not unlikely that many of the carp in the lake may enter the bays and rivers when there is an easterly wind, it seems that if this were

generally true with all storms, whatever their direction, it would surely be known to the fishermen, who utilize this movement of the fish in the river for their capture, as will be explained later.

As mentioned above, the water level at the upper end of Lake Erie is very variable. The long axis of the lake lies nearly west-southwest and east-northeast, so that both westerly and easterly winds have a great influence in piling the water at one end or the other. The prevailing winds of summer are southwesterly to westerly, so that the level is almost constantly changing. This gives a great resemblance to tides, except that the changes are, of course, much less regular, and generally of less amplitude. A strong southwest wind, however, blowing steadily for a day or two, will lower the general water level in Sandusky Bay, for instance, a foot or more, while a long-continued storm may result in an even greater change of the level. As soon as the wind ceases, or shifts around to the opposite direction, as is usually the case in our cyclonic storms, the reverse current sets in, affecting the water for miles up the Sandusky and Portage rivers.

Just how far this variation of the water level and the consequent reversion of flow of the rivers influence the movements of the carp I am unable to say. This much, however, is certain. A fall of a foot or even less in the general water level means the laying bare of great expanses of marsh land, and the carp which were feeding over this area have to seek deeper water as that on the flats gradually becomes shallower. In this way they work into the smaller streams, and so into the larger creeks, and from these into the river. It is at such times that they are taken in large numbers in a seine which has previously been stretched across the mouth of the creek, as will be described more fully in connection with the methods of fishing (p. 613). The fish appear to be quick to appreciate the lowering of the water, for they begin to run out very soon after it has begun to fall. Conversely, they run up again and spread out over the marshes as the water rises.

This movement, which seems to depend upon the gradual lowering of the water in the shallow places, is distinctly different in nature from the ordinary reaction of most fishes to a current of water. As is well known, most fishes, when placed in running water, immediately react by turning head-up into the current.[a] That this is true of young carp, I have ascertained by experimentation. It may also be the explanation of the crowding of these fish around the inlet when fresh water is being pumped into a pond, a phenomenon which will be described more fully in the discussion of their reaction to fresh water (p. 560). It is equally true that most fish become uneasy as the water in a vessel or other container is gradually lowered without producing a definite strong current. It is probably this "uneasiness" which causes the fish to leave the marshes as described above.

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[a] For a discussion of the orientation of fish to running water see a recent paper by Lyon (1904).

As to the movements of the fish in the wintertime, when the rivers and bays are frozen over, I have no information. That they are in the deeper parts there is no doubt, and it seems likely from what I can learn from the fishermen that they must move about more or less even during the coldest weather. They are occasionally taken in numbers at this season, I am told, by means of a seine hauled under the ice.

It will be seen from what has been given above that, although they apparently do not have any regular and definite migrations, carp do make considerable movements dependent upon the conditions under which they live. It was at one time thought there might be some evidence to show that in Lake Erie the carp were coming to make a rather regular migration into the deeper parts of the lake with the approach of cold weather. The lake grows deeper to the eastward, and this would mean a general movement to the eastward in the fall and to the westward again in the spring. This habit in time might become established into a definite migration. But though the fish do undoubtedly seek deeper water in the winter, they probably go only far enough to escape freezing and the effects of storms. So long as they both feed and spawn in shallow water there is no other need for a migratory habit, unless perhaps the overpopulating of the more favorable waters may force some of the fish to seek new grounds. Reports of large schools of carp at times seen toward the eastern end of the lake seemed to lend some support to this view. Thus I was told by Mr. Crangle, a fisherman in Cleveland, that some time in July, 1901, large schools of carp were seen in the open lake. In near shore were small fish, while farther out were schools of large ones, which were noticeable from their swimming about with their dorsal fins out of water. Mr. Crangle says this was the first time carp had been seen in this part of the lake in such numbers; and he was certain of the identification, because his tug was run right in among them. Prince (1897) maintains that the carp has an inherent nomadic tendency, and thinks it is owing to this, in large part, that it has gained such a wide distribution. He says (p. 33):

German carp are nomadic in their habits, and wander apparently aimlessly into all accessible waters, hence if introduced into any streams or ponds adjacent to and connected with others, these fish will rapidly spread over the whole system. Salmon, trout, white-fish, pickerel or doré, indeed all our native fish are more local in their wanderings and as a rule have definite courses of migration, and confine themselves within recognized limits. The German carp has no such defined movements or habitat, thus Lake Erie, the St. Clair waters of western Ontario, Lake Huron and other Canadian areas are being overrun by these fish, which have wandered from the more or less remote localities in United States territory where they were originally planted. Like undesirable weeds they spread everywhere and it is practically impossible to limit their progress or to effect their extirpation.

REACTION OF CARP IN PONDS TO INFLOWING FRESH WATER.

This reaction, which is very curious and marked, I am uncertain whether to consider a reaction to the current caused by the inflowing water or a response to the volume of fresh water being added to that which has been standing in the pond. Hessel (1881, p. 879) says:

> The inflow of water into the pond should never be allowed to be direct; as, for instance, a brook falling into it. This often causes the water to rise at an inopportune time, carrying into the pond other fishes, especially the rapacious pike. *The carp also has the disposition to swim toward the inflowing water, by which means it is drawn away from its proper feeding-places.*[a]

This matter was first brought to my attention in a practical way by Mr. Thomas Hurrell, who owns a carp pond near Port Clinton, Ohio. This pond covers an area of some 20 acres, or more, of marsh land beside the Portage River. A deep cut was made along the riverside and embankments thrown up on three sides so that it is possible to keep the water level two or three feet above that of the river, the fourth side of the pond being formed by the natural slope of the land. The water is maintained at a nearly constant level by pumping in fresh water, as necessary, from a dredge-cut just outside the embankment which leads from the river. The water is really elevated by means of an endless-chain elevator. This is shown in figure 2, plate III, while figure 1, plate III, shows the chute which empties into the pond. At this place the water in the pond is some 8 to 10 feet deep, and directly from it leads the deep ditch along the riverside, while shallower ditches lead off into other parts of the pond. (See figure, p. 628.) Mr. Hurrell said that scarcely has he started the elevator when the fish begin to come from all parts of the pond and to congregate in the deep area where the fresh water pours in. His account of their quick response seemed almost incredible, and I expressed a desire to see the thing myself; at which Mr. Hurrell kindly started the gasoline engine operating the elevator, and at once a good stream of fresh water began to be poured into the pond. I was subsequently fortunate enough to witness the phenomena I am about to describe on several different occasions. The following account is taken with little change from my notes of one time:

At the time of which I am speaking, a number of carp could be seen swimming about in the vicinity of the pumping house with their backs out of water. Mr. Hurrell attributed this to the fact that he had recently been pumping, and that the fish had not all dispersed as yet. He now started the engine again, and within five minutes the carp began to congregate in numbers in that vicinity, and they could be seen coming far down the large ditch, as many of them swam with their dorsal fins above the surface. The water near the inflow was soon full of them—it seemed as if there must be a number of tons of fish right

[a] The italics are mine.

there. They worked continually up toward the chute, where the water poured in, heading for the most part in that direction, but turning and twisting slowly about. They became so numerous after a time that the upper ones seemed almost forced out of the water, and many were turned over on their sides at the surface. Figure 4, plate III, shows a nearer view of the writhing mass of fish, all struggling to get nearer to the source of incoming water, though their movements appear rather slow and deliberate. Here it will be noticed that some of the fish are turned on their sides, and by the exposed backs it can be seen that they are nearly all headed in the same direction—to the right in the photograph. It was impossible to estimate the number of fish; there was no way of telling, in fact, whether they were mostly at the surface or whether they were as numerous deep into the water. I found, however, that at a distance of 20 to 30 feet away, where few backs were to be seen at the surface, an oar could not be put down into the water without hitting fish. Before long those nearest the chute began jumping out of water, some jumping to a height of nearly 2 feet into the air. Others made a jump and swam up the chute against the current as salmon leap a waterfall. Most were able to get up here but a short distance, while others worked up the whole length of the chute, some 6 or 8 feet, to the elevator itself.

From the actions of the fish in the vicinity of the inflow it seems as though they must be reacting to the current. There is no direct evidence that the response is anywhere to the fresh water and not to the current, as it is evident that to any part of the pond where the fresh water comes so as to influence the fish there must necessarily be some current. The part that seems incredible is that it should so soon effect remote parts of the pond with sufficient strength to produce a positive rheotactic response on the part of the fish. It will be noted, furthermore, that if this is the correct explanation the response appears to be just the opposite of what has been given above for fish in the marshes when there is a change in the general water level of the river. There the fish ran with the current, spreading out over the feeding grounds; here they come against the current as far as they are able to come, and crowd about the inflow. What may determine the difference in the nature of the responses in the two cases I am unable to say.

HIBERNATION.

Most observers agree that during the cold months in the temperate regions carp seek the deeper holes in pond or lake, where they pass the season in a semitorpid condition. It is said that they assemble in circular groups with their heads together and pointed somewhat downward towards the mud. During this time they take no food, though they are said to decrease but little, if at all, in weight. I know of no

statement as to whether the respiratory movements are suspended, and I have myself had no opportunity to observe carp in this condition. When I visited Lake Erie in November, 1901, some carp at least were still moving about, as they were taken in small numbers daily in the pounds and gill nets set for white-fish. This in spite of the fact that the weather was very cold, with frequent snow squalls, though the lake had not yet begun to freeze. Examination of the stomachs of these fish showed, too, that they had been feeding, though in no case was there much food in the alimentary tract. This observation agrees with the statement of Brakeley (1889), who says that instead of hibernating with the nose in the mud for several months, as they do in Europe, in this country they do so only for a short time, if at all.

VITALITY.

Many instances have been reported to show the extent to which carp can resist cold. I can not do better than to quote a case reported by Smiley (1886, p. 676):

On the morning of January 4, 1884, 2,100 German carp were forwarded from Washington, by express, to Birmingham, Ala. Mr. F. L. Donnelly, a messenger of the Commission, proceeded by the same train to watch them on their passage and to take charge of them upon their arrival at Birmingham. The fish had been placed in the usual 4-quart tin pails, and packed in crates of 16 pails each. Each pail contained 15 carp.

Mr. Donnelly and the carp arrived at Birmingham at 1.30 a. m., January 6. The packages were left in the office of the Southern Express Company through the remainder of that night, but placed within 10 feet of the stove in order to prevent the water freezing. The thermometer indicated +4° F. at the time of arrival. At 8 o'clock on the morning of the 6th Mr. Donnelly examined the condition of the fish, and in his official report dated January 14, says:

"I was greatly surprised to find every drop of water in the buckets frozen into solid ice, and all the fish apparently dead; but upon close examination of their eyes, I thought perhaps a great many of them were still alive, though frozen solid in the ice."

Mr. Donnelly thereupon courageously undertook to see if any of the fish could be saved. He procured the necessary laborers, four large tubs, and a supply of water. He then broke the ice from the small pails, transferring such as contained carp to the water. He states that "in this manner a great number of fish were soon freed from their confinement, and by constant working with them during the entire day we were able to save 1,300 fish." Although the thermometer continued to remain in the vicinity of zero, by careful management he succeeded in keeping the 1,300 fish alive until the 8th and 9th, when they were distributed to the applicants throughout the State.

The saving of 1,300 carp out of a lot of 2,100, under such circumstances, may be considered a very remarkable achievement.

Having prepared the foregoing statement from Mr. Donnelly's report, I sent a copy of it to Mr. L. H. Black, route agent, Southern Express Company, Montgomery, Ala., asking how far he knew the statements to be true. Under date of January 25, 1884, he wrote me in reply as follows:

"As route agent of the Southern Express Company, my duties call me to Birmingham. I saw the carp first on the morning after their arrival at Birmingham, and frequently during the day while Mr. Donnelly was at work with them. My opinion

is that this statement is correct in every particular. I give it from what I saw myself, and from information Mr. Donnelly gave me during the day while he was working with the fish."

Smiley gives another instance (p. 698). This is the statement of Dr. George Wigg, Clay Center, Clay County, Kans., and is as follows:

I have a German carp in my office that has been frozen stiff on 16 different occasions in one month, and yet each time resuscitation has been produced after the lapse of six hours.

Although known as cold-blooded animals, the internal temperature of fishes is normally somewhat higher than that of the water in which they are living. According to Knauthe (1896) the amount of this difference depends upon the condition of nourishment, and varies in the different races of carp. In the winter, when no nourishment is taken and the vital processes are mostly suspended, the temperature of the body becomes the same as that of the surrounding water, and Knauthe states that the crowding together at the bottom of such fish as the carp, tench, and barbel does not help to keep their temperature up, as is maintained by some authors.

The hardiness of carp in enduring low temperatures for a long time without serious result is sometimes utilized in shipping them, by placing ice in the water to keep the temperature down. The normal activities are then much reduced, the respiration is retarded, and the fish can consequently stand a much longer sojourn in a small amount of water than would be possible at ordinary temperatures. I am told that the fish packed in ice even at points in Illinois and northern Ohio are sometimes still alive when they reach New York, in spite of the fact that they are sent by freight. Townsend (1902 *b*, p. 677) says those in the top layers will live two or three days; those below die sooner. In this case, of course, they are out of water entirely, though the gills are prevented from drying and the fish are kept moist by the gradual melting of the ice.

Like many other hardy fish, carp can be kept alive out of water for considerable periods at ordinary temperatures if they are kept moist, and they are often transported for short distances by packing them in wet moss. In Germany it is said to be a common practice at such times to place in the mouth of the fish a piece of bread or cake soaked in brandy. The statement is commonly quoted, especially in European works dealing with the subject, that carp are sometimes packed in moss with the head protruding and are kept in this condition for weeks or even months (!), being nourished in the meantime by placing food in the mouth. As an example of what is often stated, the following may be quoted from Day (1880–1884, p. 160):

Pennant observes upon the following experiment having been twice made, of placing a carp in a net well wrapped up in wet moss, the mouth only remaining out, and then hung up in a cellar or some cool place, the fish being frequently fed with bread and milk, and often plunged into water. Thus treated it has been known to live above a fortnight, and grow very fat as well as lose its muddy taste.

Whatever may be the truth as to the above, it is certainly a fact that these fish can withstand much in the way of adverse conditions, and can live for a considerable period out of water so long as the gills are kept moist. When it is desired to transport fish from where they are caught it is usual for the fishermen merely to load them into the bottom of a boat when the distance is not too great. For longer distances by water they are usually towed in a live-car.

When the United States Fish Commission was distributing many thousands of young carp every year it became a matter of great importance to have some practical method that would be economical as well as efficient. The original plan was to send a few fish in a large milk can full of water, but this practice was expensive and unsatisfactory. Later it was found that the fish could be shipped long distances, requiring several days or a week for the journey, merely by putting them in small pails with only a little water. The usual method was to use 4 or 6 quart tin pails, in which were placed 15 to 20 young fish 2 to 3 inches long, with little more than enough water to cover them (see McDonald, 1882, and later reports of the Commissioner). This small amount of water is kept well aerated by the jostling of the pails in transportation and the movements of the fish. In fact, it usually becomes foamy, on account of the slime secreted by the fish. I have myself used this method with success in shipping young carp from Port Clinton, Ohio, to Ann Arbor, Mich., the fish being about two days on the way.

Although carp will live so long out of water if the gills are moist, or in a small amount of water well aerated, they succumb much more quickly to foul water—that is, to water not well aerated, and consequently charged with carbonic acid or unoxidized organic matter. Under such conditions they may usually be seen swimming about with their mouths at the surface, a circumstance that is always to be looked upon with suspicion by the owner of a carp pond, as it usually means that the fish will die unless the conditions are quickly improved. Carp are apt to do the same thing when the temperature of the water becomes too high. Of course this action must be distinguished from the normal feeding of the fish at the surface.

FEEDING HABITS AND FOOD.

Carp are frequently stated to be "essentially vegetable feeders." It seems to me better to say that they are omnivorous, for I know of no food substance which a carp can get into its mouth that it will not eat. Since it can not be considered in the ordinary sense a predacious fish, however, the animal matter which it can ordinarily obtain is limited largely to insect larvæ, small crustacea and mollusca, and other similar small organisms, so that the bulk of its food is undoubtedly in most cases vegetable. Carp are often compared to pigs in their feed-

ing, and the simile is not bad, for much of their food is obtained by rooting about in the mud. In soft muddy or marly bottoms one will often see numerous little pits and holes a few inches, or often more, in diameter, showing where the fish have been at work. In most of its feeding the carp works slowly and rather quietly, though persistently; but the rooting in the mud they often undertake in a more vigorous manner, twisting and splashing, and tugging at the roots of water plants. It is this that makes the water so roily, and anyone familiar with their habits can tell at once the presence of carp when they are feeding in this manner simply by the appearance of the water. Moreover, the freshly dug up stems and leaves of cat-tails, sweet flag, wild celery, and other water plants are often to be seen floating about, furnishing further evidence of the destructive work going on below. The extent to which the character of the aquatic vegetation is changed in this way will be discussed later, when we come to consider the economic aspects of the question. The fish probably dig up these plants mostly for the tender shoots and rootlets, but they undoubtedly obtain many smaller organisms from the mud at the same time. The barbels at the sides of the mouth, which are well supplied with taste buds, are probably of much assistance in helping to ascertain the presence of food particles in the mud. I have not been able to observe the process in natural surroundings, but judging from the actions of small carp kept in an aquarium, I should say that much of the mud is sucked into the mouth and further "tested" for food by the more efficient[a] organs there; if satisfactory it is swallowed, if not it is rejected. The fish will often take into the mouth in the same way particles floating in the water, some of which will be swallowed and others rejected in a manner similar to that described by Herrick (1903, p. 265) in the sea robin (*Prionotus carolinus*). In respect to the distribution of the organs of taste and the manner of feeding, carp would thus appear to be midway between such forms as the cat-fishes on the one hand, which have a well developed sense of taste over the entire body, and the sea robin on the other, in which taste is confined to the mouth.

Carp do not, however, do all their feeding at the bottom by any means. Where the water is shallow and clear they may often be seen swimming slowly about, skimming floating particles of food from the surface or working industriously along the stems of the water plants. At the surface they probably get small floating plants, insects or their larvæ, such as mosquitoes, May flies (or "June bugs," as they are popularly called along the lakes), etc., as well as the seeds of plants, and other substances which are dropped or blown into the

[a] Herrick (1903, p. 267) says that "the delicacy of the sense of taste in the skin is directly proportional to the number of terminal buds in the areas in question." In the carp these buds are especially well developed on the "palate."

water accidentally. In feeding at the surface the fish swim about with the anterior part of the head showing, the mouth partly above water, partly below. The mouth is continuously opening and closing, and a sharp sucking or smacking sound is often produced, much as is made by a pig with his head down in the trough.

Much of the carp's food is obtained by foraging along the stems of water plants, and it also often eats quantities of the plants themselves. Many of these stems are covered with a considerable growth of algæ, bryozoa, etc., among which live a variety of minute, and even microscopic, plant and animal forms. Such stems as float on the surface or lie in a horizontal position in the water can be gone over very easily, and sometimes this appears to be done in a more or less systematic manner, the fish beginning at one end and working gradually along to the other. In order to get at the vertical stems the fish often turn on their sides, when the mouth can be closely applied to the rounded surface. They were also often seen to take the end of a floating stem or leaf, such as a cat-tail leaf, into the mouth and then pull and tug at it vigorously. Even if they did not get off pieces of the stem in this way, they undoubtedly pulled off the algæ and other substances growing on its surface. In one case I noticed a fish swimming about with a piece of partially decayed stem sticking from its mouth, but whether it was finally swallowed I can not say, as the fish swam away out of sight with the stem still protruding.

Few records of the food of the carp in this country made from examination of the contents of the stomach and intestine seem to have been previously reported. H. Garman (1888) reported on one specimen from Broad Lake, Ill., soon after the species began to be found in the waters of that state. According to him the food "consisted of vegetation and mollusks, the former constituting two-thirds of the material in the alimentary canal, and consisting of dead leaves and seeds. The seeds were, as far as could be determined in a hasty examination, chiefly those of trees and weeds. Elm seeds, ragweed seeds, and the seeds of *Polygonum* were noted. The mollusca were partially thin-shelled clams with an occasional *Sphærium*, and partly snails, such as *Physa* and *Lioplax*. All the matter was apparently gathered from the bottom. No trace of crustacean or insect food could be detected."

In August, 1900, Mr. M. C. Marsh collected carp stomachs near Bellevue, on the Mississippi River, near Omaha, and from Maumee Bay and River near Toledo, Ohio. Apparently no detailed study of these collections has been made, but Smith (1902), in his report on food fishes, gives a few general data. He states (p. 120) that the food was found to be largely microscopic, and contained in what was apparently a mass of mud passed on into the intestine, where he thinks the digestion probably takes place. Portions that were recognizable

macroscopically were rarely seen. In a few cases fragments of the higher water plants (e. g., *Ranunculus*) were found in the esophagus, while from the color of the small amount of fluid contents it was believed that green algæ might have been eaten. In the Maumee River the carp fed constantly and largely upon whole wheat that had been lost in the river a season or two previous in a grain elevator fire.

From the foregoing it appears that a large proportion of the material found by dissection in the alimentary tracts of carp was of vegetable origin. Since this material is eaten in such quantities and is digested in its course through the fish, as is shown by observation, the natural supposition is that it serves as food. And such is the opinion of most writers on the subject. Nicklas (1884), however, who discusses at much length the question of the proper food for the "artificial feeding" of carp, arrives at a different conclusion. It is his theory that these fish should be fed on materials especially rich in nitrogenous compounds, and in this connection he says (pp. 1011, 1012):

> I have started my theory from the fact, which I know from actual experience, that the food of the carp is principally animal and not vegetable matter, and I find that in this I agree with most of the practical pisciculturists; but I differ from the views of Professor Nawratil (Oesterreichisch-Ungarische Fischerei-Zeitung, 1880, No. 35) when he asserts that carp, from their third year, live principally on fresh and decaying vegetable matter. This is contradicted by the experience that they are easily raised in ponds which contain but few plants, and by the circumstance that, if aquatic plants formed the exclusive, or even principal food of carp, vegetation would, in some ponds, be utterly destroyed in a few days after they had been stocked with carp, or at any rate in a couple of years, as carp are particularly fond of young shoots, which, by the way, show a pretty close proportion of nutritive matter [to animal food?]. Such an occurrence, however, I have never yet been able to observe, nor has it been observed by any other pond-culturist; whilst, on the other hand, it has frequently been observed that in carp-ponds vegetation becomes so rank and luxuriant that it has to be checked. As long as decaying vegetable matter has not been examined as to the quantity of nutritive substances contained in it, no opinion can be formed as to its suitableness for carp food.
>
> My own observations have taught that the carp only takes to vegetable food when absolutely no animal food can be procured. I have not yet been able to ascertain whether the carp actually eats and digests decaying vegetable matter, because all I have so far been able to observe has been that the carp often swallows such matter, but almost immediately ejects it again, perhaps after having devoured worms and insects clinging to such matter.

I can not help feeling that Nicklas's judgment is influenced by his theory. Although he may possibly be right as to the kind of food that will be most economical in putting a given amount of flesh on a carp in a given time, it nevertheless seems evident, as a matter of fact, that carp do under natural conditions eat a large quantity of vegetable food. If Nicklas had examined the contents of the stomachs and intestines of the fish he observed, he might not have concluded that they ejected even all of the decaying vegetable matter that they ate. While it is not probable that the actually decaying vegetable matter

contains a great deal of nutritive material for the fish, this does not dismiss the whole question of vegetable food, as Nicklas implies; and while he says that carp can be raised in ponds which contain but few plants, being fed, I suppose, on animal food, on the other hand I have seen ponds in northern Ohio, where carp were retained from spring to fall, which contained practically no natural food at all, the water being supplied from artesian wells, and where the fish were fed exclusively on corn, barley, etc., and young "sowed corn," the plants being cut when 1 to 2 feet high and thrown into the pond. I am not prepared to say that these fish grew as rapidly as they would have if fed according to Nicklas's formulæ. But this does not concern us here. The important point is that carp can live very largely, if not entirely, on vegetable materials, and that under natural conditions in our open waters plants and plant products form a very large share of their food. The bearings of this, from an economic standpoint, will be discussed later on, where will also be considered the question of the extent to which carp may be injurious to the spawn and young of other fish.

Susta maintained that of its own choice carp would first select animal food, a contention in which he was supported by the observations of A. Fritsch in Prag and Emil Walter in Trachenberg. Karl Knauthe pointed out that these investigators had used exclusively the highly cultivated races, to which belong the so called Galician and Bohemian carp. He himself extended the investigation by comparing as to intestinal contents examples of the old Silesian carp and a new race of it bred by Gröger in Lauterbach with examples of the two quick-growing races mentioned above, using for the purpose fish of the same age. These fish, after each individual had been marked so that the four races could not be confused, were placed all in the same pool, which was rich in animal and vegetable food. In this way it was shown that the stomachs of the Galician and Bohemian carp were generally filled with small crustacea—chiefly *Daphnia* and *Cyclops*—as long as these were abundant, while insects and their larvæ were second only, in about the proportion of 3 to 1. Plant food was present only as it was taken incidentally with the other. In the cultivated Silesian carp the proportion of animal to plant food was about the same. The old Silesian "Bauernkarpfen," however, contained a great preponderance of vegetable materials, such as algæ, diatoms, plant débris, and the seeds of higher plants, and only a few animals, mostly small crustacea. As soon as the supply of lower animals in the pool was exhausted it became necessary for the Galician and Bohemian carp to adopt a vegetable diet as well. Moreover, Knauthe found the stomachs of these carp filled with a small species of pond snail which was abundant in the pool, and which both of the Silesian races spurned. From such and similar researches of Knauthe's it was shown that in

the spring the Silesian carp, though apparently well nourished, had reached a length of only 5 to 6 cm., while the Galician carp had grown to a length of 18 cm. The author answers the question, Wherein, under natural conditions, rests the ability for quick growth in fresh water fishes? by saying: "Partly, perhaps, in a better assimilation of the food, but mostly upon a better selection of the same. The richer this is in nitrogen, the greater, within certain limits, is its nutritive effect." (Zoologische Garten, Jahrgang 37, 1896, p. 345, 346.)[a]

In order to determine the nature of the principal food of the carp in this country I have examined the alimentary tracts of a great many individuals. Many of these examinations were not made in detail, but only to determine the presence or absence of certain things, such as the eggs of other fishes. A list of the contents of stomachs and intestines of 33 carp, however, is given below. These examinations were made with more care than the rest, but are for the most part only qualitative, the relative quantities of the various materials being given only in rough approximates. The carp were from several different localities and a variety of conditions. The list is given in full because it is believed to be important to convey a very thorough knowledge of the nature of the food of the carp in our waters. I have never found large particles of food of any kind in the alimentary tract, the largest being strips of vegetable epidermis perhaps an inch long, wings and other portions of insects, small snail shells, and the like. It is stated that carp can grind or "masticate" thin food to a certain extent with the flat, knob-like pharyngeal teeth, and probably this in part explains the fact that what is found in the stomach is usually so much broken up. Houghton (1879, p. 17) even maintains that "portions of vegetable food are returned to the throat and remasticated by these pharyngeal grinders," though I know of no evidence in support of this hypothesis. The finely ground condition of the stomach contents leads to some wonderment among the fishermen, who are accustomed in other fish to find the food, such as smaller fish, swallowed whole, and one man always insisted to me that carp "digest their food in their heads."

1. Specimen from St. Clair Flats, June 30, 1901. *Chara*, small amount; May fly (ephemerid) wings and broken fragments, considerable numbers; insect larvæ, small; roots, decaying leaves, and epidermis ("bark") of aquatic plants, large amount; small shells and fragments; sand. All the *Chara* seemed to be packed in the small intestine. This was noticed in other cases, and seems to indicate that when the fish get among the *Chara* they eat a large amount of it.

2. Specimen from St. Clair Flats, July 3, 1901. Rootlets and other vegetable matter, such as would be found in bottom mud; coleopter-

[a] For a more detailed discussion of the processes of digestion and assimilation in the carp, the reader is referred to a later paper by Knauthe (1898).

ous larva, small; algæ; fine shell fragments with fine sand or mud, forming a "grit."

3. Specimen from St. Clair Flats, July 13, 1901. Large mass of remains of Ephemerida, consisting for the most part of wings and of more or less broken up cercopods. (Fore wings 18 mm. long; one of the larger of the cercopods had 25 or 26 joints.) Very few other parts of the insects in evidence, except small opaque bodies with elliptical outlines, which were probably the eyes. The fact that the insects were adults would indicate that they were taken from the surface of the water either at the time of metamorphosing or when blown into the water later.[a] This one carp must have contained hundreds of these insects. Prof. R. H. Pettit, entomologist at the Michigan Agricultural College, kindly examined the remains of these May flies (or "June bugs") for me, but was unable to determine the species from the material in hand.

4. Specimen *45 cm.*[b] long from North Bass Island, Lake Erie, July 19, 1901. *Chara*, considerable; copepods and ostracods, numerous; *Chironomus* larvæ or related forms; fragments of shells (mostly quite small), considerable; plant fibers.

5. Specimen *27 cm.* long from North Bass Island, Lake Erie, July 19, 1901. Mass of food quite well digested. Much filamentous algæ (*Spirogyra* recognized) and diatoms.

6. Specimen *55.5 cm.* long from Put-in Bay, July 27, 1901. *Chara*, bulk of material, packing intestine full in places, mostly in small pieces less than 1 cm. long; May-fly larvæ, 1 to 1½ cm. long, large numbers; shells, broken pieces, and small bivalves 2 to 4 mm. long, entire; *Chara* and considerable other vegetable matter, some of it probably *Philotria;* mud, fine débris, evidently bottom sediment.

7. Specimen *33 cm.* long from Put-in Bay, July 27, 1901. *Chara*, mass of the material as in No. 6; amphipods, a number of small *Hyallela*-like individuals; broken shells, a very little; vegetable matter, a little besides *Chara.*

8. Specimen *38.5 cm.* long from Portage River, about 3 miles above Port Clinton, August 6, 1901. About 90 to 100 c.c. of rather fine, dark material, composed almost entirely of finely divided vegetable matter. A few filamentous algæ.

9. Specimen 50.5 cm. long from Portage River, as above, August 6, 1901. A considerable quantity of blackish "mud", vegetable fragments, pieces of stem, etc., the principal constituent; one pulpy mass, apparently an unopened bud of some kind, possibly "lotus" (*Nelumbo*) or water-lily; insect larvæ, occasional, head only recognizable.

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[a] On Lake Erie I have seen windrows of the cast pupa cases of ephemerids being drifted about by the wind, and extending as far as the eye could follow them. If carp could have got among these at the time the insects were leaving they would have had abundance of food for a time.

[b] Length of fish if in italics means total length—i. e., tip of snout to end of caudal fin; if in Roman type it is the length from tip of snout to base of caudal fin at middle.

10. Specimen 33 cm. long from Portage River, as above, August 6, 1901. Some 20 to 30 c.c. dark mud-like material, consisting mostly of plant fibers, fragments of stems, etc.; one young shoot (apparently of grass) about 18 mm. long.

11. Specimen 36 cm. long from Portage River, as above, August 6, 1901. Small amount of material of the appearance of fine mud; under the microscope seen to consist for the most part of finely divided vegetable matter and some filamentous algæ.

12. Specimen 47 cm. long from Portage River, as above, August 6, 1901. About 150 c.c. of material composed for the most part of vegetable matter—short pieces of stem, etc.; some pulpy vegetable matter, probably roots or bulbs of some aquatic plant; insect larvæ, occasional fragments.

13. Specimen 36 cm. long from Portage River, as above, August 6, 1901. Six to 8 c.c. of very fine material resembling mud in appearance, almost entirely composed of vegetable matter; vegetable fibers and some filamentous algæ recognized.

14. Specimen 44 cm. long from Portage River, as above, August 6, 1901. Only 2 to 3 c.c. of fine "mud", consisting of plant fibers, fragments of stems, etc.

15. Specimen 36 cm. long from Portage River, as above, August 6, 1901. Ninety to 100 c.c. of rather coarse dark material, mostly plant fibers and fragments; some pieces of leaves or stems 1 inch long, but most are smaller.

16. Specimen 32 cm. long from Portage River, as above, August 6, 1901. Small amount of very fine material. Most that is recognizable is portions of plant tissues—largely fibrous parts, and what appear to be the glumes of grasses.

17. Specimens 39 cm. long from Portage River, as above, August 6, 1901. Fifteen to 20 c.c. of dark grayish, almost black material, almost entirely composed of vegetable fragments.

18. Specimen 38 cm. long from Portage River, as above, August 6, 1901. Small amount of dark muddy material, mostly plant fibers and small pieces of other plant tissues; considerable filamentous algæ; insect larvæ (dipterous?), occasional.

19. Specimen 37 cm. long from Portage River, as above, August 6, 1901. Some 20 to 40 c.c. of fine, dark mud-like material consisting of vegetable fibers, fragments of stems, leaves, etc. Very little material in which vegetable cells could not be made out.

20. Specimen 34.5 cm. long from Portage River, as above, August 6, 1901. Fine material consisting mostly of filamentous algæ and partly digested tissues of other plants.

21. Specimen from "The Straits," 1 mile east of Cedar Point near Maumee Bay, August 12, 1901. Plants, pieces of stems, etc., considerable; algæ (filamentous), considerable; maxillæ of insects (?),

comparatively few; insect larvæ, few; diatoms; Vorticellæ; gastropods (?), few small fragments; much flocculent débris with small fragments of many kinds in it.

22. Specimen from Port Clinton, Ohio (from gill-nets in Lake Erie), November 16, 1901. Shell fragments, many, some of them 3 to 4 mm. in diameter; insect larvæ, fragments, caddis-fly (?) and some chironomid (?).

23. Specimen from Port Clinton (from Lake Erie), November 18, 1901. Shells, few small fragments; larvæ of caddis-fly (?), heads and other fragments; most of the mass of material appears to be made up of the nearly digested bodies of these larvæ. White-fish egg, one.

24. Specimen from Port Clinton (from Lake Erie), November 18, 1901. White-fish egg, one; larvæ of caddis-fly (?); entomostraca, mostly fragments; much of the material unrecognizable.

25. Specimen from Port Clinton (from Lake Erie), November 18, 1901. Shells, few fragments; algæ, few; apparently also other vegetable remains very finely divided; larvæ or worms of some kind, fragments; bulk of material unrecognizable.

26. Specimen from Port Clinton (from Lake Erie), November 19, 1901. Mostly fragments of *Chironomus* (?) larvæ.

27. Specimen from Port Clinton (from Lake Erie), November 19, 1901. Many remains of chironomid (?) larvæ (same as No. 26), much broken up; bulk of material unrecognizable.

28. Specimen from Port Clinton (from Lake Erie), November 19, 1901. Only small amount, about 2 c. c., in intestine; shell fragments; filamentous algæ; entomostraca, fragments, largely ostracods; caddis-fly (?) larvæ, much digested.

29. Specimen from North Bass Island (Lake Erie), November 27, 1901. Shells, 2 to 5 mm. in diameter, and shell fragments; ostracods, numerous, fragments of entomostraca in general.

30. Specimen from North Bass Island (Lake Erie), November 27, 1901. Shell fragments; entomostraca, fragments; insect larvæ, caddis-fly (?), fragments.

31. Specimen from North Bass Island (Lake Erie), November 27, 1901. Shell fragments, nearly one-half of material; ostracods, few; insect larvæ, caddis-fly (?), fragments; white-fish egg, one.

32. Specimen from North Bass Island (Lake Erie), November 27, 1901. Only a small amount of fine material, composed mostly of ostracods, Cladocera (?), and copepods, mostly fragments, some almost entire.

33. Specimen *46.4 cm.* long from Port Clinton (seined in Lake Erie), August 31, 1902. Principal material appears to be seeds of some sedge; aside from these the mass is largely fragments of plants and unrecognizable débris.

As to whether the fish were wont to feed most at any particular

time of day, I obtained no very satisfactory data. Neither did I find any other conditions which seemed regularly to influence their feeding. It is stated by some authors—and I have some evidence to bear them out—that carp feed especially in the early morning and late in the afternoon. But I have frequently found them feeding at all other times of day, even in the hot midday sun of summer. This much seems to be true, however, that they are usually more quiet in the middle of the day; one does not hear them splashing about so often. In the late summer, the fishermen tell me, the carp in Lake Erie, at least, feed mostly at night. As to the time of year, Seeley (1886, p. 97) says, "Like many other fishes, it feeds most frequently before the spawning season." In Europe they are said not to eat at all during the winter months. In this country I have reason to know that they do, to some extent, at least.

BREEDING HABITS.

In Europe the carp is said to spawn principally in May and June, though in some cases the process extends several weeks longer. As well as I can ascertain, the same statement holds for the northern United States. In our Southern States and California spawning is apparently earlier, often beginning in April. In the waters contiguous to Lake Erie the height of the spawning season seems to be in the latter part of May and early June. On the St. Clair Flats I believe it is usually a little later on account of the lower temperature of the water, which comes directly down from Lake Huron. This temperature difference affects the time of spawning of the bass, dog-fish (*Amia*), and other shallow-water spawners as well, for I have found the eggs of these fish at the Flats when the season for them was entirely past in the interior lakes and rivers of the state.

The age at which carp spawn also depends largely upon the temperature. European authors state that they reach maturity in the waters of temperate Europe when they are 3 years of age, and the same probably holds true in general for the corresponding region in North America, though apparently they sometimes spawn, at least in the latitude of New Jersey, when they are only 2 years old (cf. statement of John H. Brakeley, Bordentown, N. J., Smiley, 1886, p. 757). Judging from other statements quoted in the same report, they commonly breed at the age of 2 years in the South (where they do not hibernate in the winter), and according to Mr. Poppe, of California (Poppe, 1880, p. 664), his fish spawned when they were only 9 months old. At the time of first spawning the fish will usually weigh 3 or 4 pounds and have a length of 15 to 18 inches.

At the spawning season, but before the fish have spawned, the females can usually be readily distinguished by their distended condition. Though the ova themselves are rather small, the number is

very large, and the reproductive capacity of a carp increases greatly for the next year or two after it begins to spawn. According to Hessel (1881, p. 871) a female weighing 4 to 5 pounds will contain on an average 400,000 to 500,000 ova. Day (1880–1884, p. 161) quotes other estimates, thus: A female of 9 pounds had 600,000 eggs (Bloch); one of 16¾ pounds had 101,200, one of 25½ pounds 203,109 (Harmer); one of 21½ pounds had 1,310,750, and one of 16½ pounds had 2,059,750 (Buckland).

In the case of a female mirror carp from Sandusky Bay, which I weighed at Port Clinton June 22, 1903, I found that the ova comprised more than a fourth of the total weight of the fish. The fish before being opened weighed 17 pounds; after the removal of the ova with as little loss of blood as possible, the weight was 12 pounds 6 ounces, leaving 4 pounds 10 ounces as the weight of the ova. This is 27 per cent of the entire weight of the fish and 37 per cent (over a third) of the weight of the remainder of the fish after the ova had been removed.[a]

This enormous fecundity is undoubtedly an adaptation to compensate for the dangers of the exposed condition in which the eggs are left after being laid, since they are merely scattered about on the vegetation in shallow water and are given no further care or attention by either of the parent fish. It may also help to explain the remarkable increase in numbers of the carp in our waters in a very short time, for if we suppose that the ordinary enemies of the eggs were not in the habit of searching for food in the kind of locality utilized by the carp for spawning, or at least were not present in large numbers, it is easy to see what an advantage this would give the carp, especially if the conditions were favorable to its growth in other respects. Furthermore, it would not be at all surprising if, as has been known to have happened in other cases, the increase in the quantity of food furnished by the abundant supply of carp eggs would favor the corresponding increase of some other fish or other animal which finds the eggs good eating. Or possibly, even, some form which has previously lived on other food may adjust its habits to the new conditions, and come to prey largely upon the spawn of the carp. It will rather be surprising if something of the kind does not happen, for in their struggle for sustenance nature's creatures are no respecters of person nor property, and it would be an unusual thing for a rich supply of food to be lying around long without some of them appropriating it. When this does occur, the phenomenal increase of the carp will undoubtedly be checked and the natural balance will again be approximated. One thing that militates against this in the case of the

[a] Day (1880–1884, p. 161) says that continued cold weather may prevent carp from spawning, so that the process may last over several weeks or months, while some fish may retain the ova, thus occasioning disease. Bean (1903, p. 169) mentions that confinement of gravid females in a small tank may also cause them to retain the eggs, and he speaks of two fish that died from this cause.

carp and greatly reduces the danger is the short time required for the development of the eggs and the rapid growth of the young fish, which quickly takes them beyond the stage where they can be preyed upon by any but the larger of their enemies.

The general manner of the breeding of the carp is well known, but, so far as I am aware, the exact method has never been studied in all its details. This I found an exceedingly difficult thing to do in the open waters, where the opportunity to observe the proceeding is very largely a matter of chance. It is not so hard to find places where the fish are spawning, but the difficulty comes in getting close enough at the right time to see what takes place, and to have the water clear enough to see into when once close. These conditions I have never had the good fortune to have fulfilled, largely because the greater part of my work in the field has been after the spawning season of the carp was past. It is stated by many writers that at the time of spawning carp are so fearless, or at least so oblivious, that a person may approach very close to them and that they may then be easily captured (Hessel, 1881, p. 872). But I have always found even the breeding fish very shy. The place to make a careful study of the breeding habits would undoubtedly be in a moderately small pond, where the fish are confined to a limited area, and where they have become more or less accustomed to the presence of people in the vicinity. In the following description I shall rely for the most part upon my own observations, amplifying them where I can with the observations of others.

As is the case with the feeding, I could not ascertain that the spawning of the carp is confined to any particular time of day, though it apparently takes place more frequently in the morning hours. Hessel remarks that it is more frequent in warm than in windy and rainy weather, which agrees very well with my observations. At such times groups of fish may be seen swimming about at the surface, usually close together in a compact mass. In the marshes along the Sandusky River, where the best of my observations were made, the fish were in shallow water, one to two feet deep, and pretty well grown up with aquatic grasses, sedges, and flags, but with numerous open places from a few feet to a few rods in diameter, where the vegetation was not so abundant. The bottom was fairly solid, being composed of the roots of the plants and much dead grass. In these open places especially the carp could be seen, usually swimming slowly about with their dorsal fins and often a portion of the back projecting above the water. These also seemed to be the favorite places for depositing the spawn, though much is also deposited about among the thicker growth.

The spawning carp would usually be seen in groups consisting of one larger fish in the lead and a number of smaller ones following closely behind, making sometimes a string of six or seven fish in line, as is shown in the first figure on the next page. It is probable that

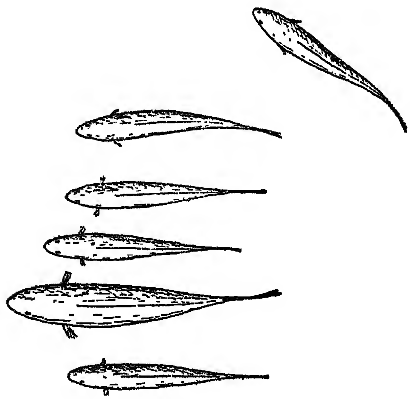
the larger fish ahead was a female and the others males, though I was unable to capture any of them at the time in order to confirm my opinion. This agrees, however, with the statement of Hessel (1881, p. 872), who says:

> Two or three or more of the male fish keep near the female; the latter swims more swiftly on a warm, sunny morning, keeping mostly close to the surface, followed by the males.

The Germans call this "streichen," or running spawning. Other writers agree in this matter, so I shall speak of the larger fish as the

Carp spawning. A female followed by a number of males.

female and the smaller ones as males, for convenience in description. As they go along, the males each appear to be crowding and pushing in to get as near to the female as possible, those behind often seeming to nose under and displace the ones ahead of them. This often gives the appearance of more or less of a struggle, and is accompanied by considerable splashing. After a time they come to rest, and four or five line up parallel to one another, as represented below, one or two males being each side of the female. They remain quietly in this way for a short time, perhaps one to two or three minutes, when one of them, presumably the female, starts forward and the others follow as before. While they are quiet, some of the fish of the group may not form in line with the others, but swim about in the vicinity, falling into line again as the procession moves forward.



Carp spawning. The fish at rest.

I was unable to tell at what moment the actual spawning took place, though I observed that at times one of the males would work forward beside the female until they were swimming nearly side by side, when he would turn somewhat on his side and bring his ventral side close under the female. At such a time the body of the male usually shook with a sort of quick vibrating movement (though this was not always observed to be the case), and it was then, too, that the most violent splashing of the water occurred. It is probably at this time that the eggs are laid and fertilized. Here again my

observations seem to agree with those of Hessel (op. cit.), who describes the process as follows:

They lash the water in a lively way, twisting the posterior portion of the body energetically, and shooting through the water near its surface with short, tremulous movements of the fins. They do so in groups of two or three males to one female fish, and forming an almost compact mass. This is the moment when the female drops the eggs, which immediately are impregnated by the milter.

To this he adds:

As this process is repeated several times, the female drops probably only from 400 to 500 eggs at a time, in order to gain resting time, so that it will require days and weeks before it has given up the last egg.

Among the earliest observations on the spawning habits of the carp are undoubtedly those mentioned by Walton (1901 ed., p. 116), which are interesting on account of their curious mixture of more or less accurate observations and quaint ideas. Walton says:

I told you that Sir Francis Bacon thinks that the Carp lives but ten years: but Janus Dubravius has writ a book *Of fish and fish-ponds* in which he says, that Carps begin to spawn at the age of three years, and continue to do so till thirty: he says also, that in the time of their breeding, which is in summer, when the sun hath warmed both the earth and water, and so apted them also for generation, that then three or four male Carps will follow a female; and that then, she putting on a seeming coyness, they force her through weeds and flags, where she lets fall her eggs or spawn, which sticks fast to the weeds; and then they let fall their melt upon it, and so it becomes in a short time to be a living fish: and, as I told you, it is thought that the Carp does this several months in the year; and most believe, that most fish breed after this manner, except the Eel. And it has been observed, that when the spawner has weakened herself by doing that natural office, that two or three melters have helped her from off the weeds, by bearing her up on both sides, and guarding her into the deep. And you may note, that though this may seem a curiosity not worth observing, yet others have judged it worth their time and costs to make glass hives, and order them in such a manner as to see how bees have bred and made their honeycombs, and how they have obeyed their king, and governed their commonwealth. But it is thought that all Carps are not bred by generation; but that some breed other ways, as some Pikes do.

It may be of interest to give one other account of the spawning, though it adds nothing in the way of accurate details. Nicklas (1886, p. 548) quotes the following from Horak:

The female fish, or spawners, accompanied by the male fish, or milters, move rapidly along the edges of the pond, or near the calm surface of the water. The actual process of spawning generally takes place during the early part of the forenoon. I have taken careful observations of this process, and have invariably noticed that several milters always accompanied one female fish, and deposit their spawn, for not all females spawn, at the same time. Sometimes this accompanying degenerates into a regular chase which lasts until the act of propagation has been consummated. At the beginning of the spawning season the fish therefore gather in large shoals and move so close together as actually to touch each other. During warm, calm weather the spawning process is carried on at so lively a rate that the water is squirted 50 to 85 cm. [20 to 34 inches] above the surface.

In another place Nicklas (op. cit., p. 523) says that in the artificial propagation of carp the spawning ponds "must contain some stones,

and in some places aquatic plants, because the female fish like to rub against stones for the purpose of ridding themselves of the roe"—a statement that I know of no observations to support; it seems much more probable that the eggs are extruded entirely by muscular action while the fish are swimming about.

In pond culture the breeding ponds are usually stocked with male and female fish in a definite proportion; the unit is technically called a "spawning party." Usage differs as to the relative number of each sex that is best for stocking a breeding pond, but it is customary to put in a larger number of females than males. It is usually planned that each "spawning party" shall consist of one "milter" and two "spawners," or else two "milters" are provided for three "spawners," while for each three milters is added one 3-year-old male fish, known as a "driver" or "enticer," which is "not used for spawning, but simply to drive or entice the other fish to that process."

According to Hessel (1881, p. 872), the male carp at the breeding season assumes a secondary sexual character which is common to many members of the family at that time, namely, a various arrangement of "protuberances, like warts," which are generally known as "pearl organs." In the case of the carp these are said to occur on the skin of the head and back. I do not remember ever to have seen them on a carp myself, and have no mention of them in my notes. If they are regularly present in these positions they undoubtedly function as Professor Reighard has found they do in other Cyprinidæ and some of the Catostomidæ, in helping to hold the female at the time of spawning—observations which have not as yet been published in detail (abstract Reighard, 1904). The method of the carp would seem to be much like that of the sucker (*Catostomus commersonii*), where the two males lie one on each side of the female, holding her firmly between them with the help of the pearl organs along the sides and tail.

Hessel also states that sometime before the spawning season sets in the pharyngeal teeth fall out and are renewed each year. On this point I have no observations.

The eggs are not laid in bunches or masses, but are scattered about in the water, and, being adhesive, they become attached to the roots and stems of grass and other aquatic vegetation, or to whatever objects chance to cover the bottom where they are deposited. The fate of the egg probably depends to a large extent upon where it chances to become attached, for should it fall into the mud there would be little chance for its further development. The eggs develop rapidly, but the time required for hatching depends very directly upon the temperature of the water. In temperate regions, under favorable conditions, they are said to hatch in about twelve days, though if the weather be so cold as to lower the temperature of the water it may take them sixteen or twenty days to reach their full development. In the warmer waters of

our Southern States the development is more rapid; in a pond in Georgia, when the temperature of the water was 69°, the eggs are reported to have hatched in five to six days, while the following year, with the water still warmer, the whole time consumed for development was but forty-eight to seventy-two hours (statement of H. H. Carey, M. D., Smiley, 1886, p. 687). The young fish also grow very rapidly and in the latitude of Lake Erie reach a length of 4 to 6 inches the first fall.

DISEASES, PARASITES, AND ENEMIES OF THE CARP.

The most remarkable fact in this connection seems to be that, although deformed and misshapen individuals are by no means rare, carp in the Great Lakes region appear to be very strong and hardy and almost free from diseases, whether such as are due to parasites or to other causes. This fact impressed me especially while I was working with them in the fish houses on Lake Erie, where I had a good opportunity to compare them with large numbers of other lake fishes. One finds intestinal parasites in almost any of the other species in great abundance, but in large numbers of carp examined I have found parasites in the alimentary tract in only one case. This was a rather large fish, which had some 16 round worms, nearly chrome yellow in color and 2 to 2.5 cm. (four-fifths inch to 1 inch) long, hanging to the walls of the intestine. Their spiny probosces were buried in the intestinal wall in true acanthocephalous fashion, and it required a considerable pull to detach them. These specimens were referred to Mr. H. W. Graybill, who studied the parasites of many of the Lake Erie fishes in 1901. Mr. Graybill reports that these are a form closely related to *Echinorhynchus proteus*, though he thinks they are possibly specifically distinct from that type. He further states that in 1901 he found in a carp a single dwarf specimen of the same worm.

Excrescences of the integument, probably caused by sporozoa, are not infrequent on the wall-eyed pike (*Stizostedion*), and were occasionally found on other species, but I did not observe them at all on carp.

In one case I found a leech attached to the base of one of the pectoral fins of a carp, but unfortunately the specimen was lost before it could be preserved, so that I have been unable to have it identified. The only Lake Erie fishes on which I observed leeches at all commonly were the lake lawyer (*Lota maculosa*) and some of the cat-fishes (especially *Ictalurus*).

There can be no doubt that the lampreys must also be considered among the external parasites of the carp, though I have never myself seen one attached to a carp. The fishermen told me that "lamper eels" were "common" up the Portage River, and I often found them among the fish brought to the wholesale house from both the river and the

lake. This was the so-called silvery lamprey, *Ichthyomyzon concolor*.[a] I inquired of the fishermen if they had ever seen the lamper eels attached to fish, and they said, "yes;" to the inquiry as to the kind of fish the reply was, "carp." On the 10th of August, 1902, I was assisting in making a seine haul of carp in the Sandusky River when one of the fishermen noticed a lamper "about 5 inches long" attached to one of the fish; it became detached, however, and escaped through the net before I could get to the place to see it for myself. Prof. S. H. Gage tells me that in his aquaria at Cornell University the young of the Cayuga Lake lamprey (*Petromyzon marinus unicolor*) have become attached to carp as soon as they were transformed from the larval stage and had left the sand. As carp are abundant in Cayuga Lake, as well as most of the other lakes in which this lamprey occurs, it seems very probable that during its free-swimming life the latter may be one of the important enemies of the carp, as it has been found to be of many other fish (Surface, 1898). In fact, Surface (p. 212) includes carp among those fish he has found dead with the marks of the lamprey on them.

Finally, under unfavorable conditions carp, like other fish, are susceptible to the attacks of fungus growths. So long as the water is pure there seems to be little danger of this, for I have seen carp that had been penned for long times whose heads were much bruised and abraded, but which were free from fungus. On the other hand, some young fish which I attempted to keep in an aquarium at Ann Arbor were soon attacked by a *Saprolegnia*, and I was unable to keep them alive for more than a few weeks on that account. The usual treatment with potassium permanganate and by immersing the fish for a short time in strong brine afforded only temporary relief. Smiley (1886, p. 754) gives the following with regard to carp attacked by fungus:

Statement of B. E. B. Kennedy, Omaha, Douglas County, Nebr., April 14, 1883.

FUNGUS.—On visiting our fisheries yesterday I find that many of the young carp are affected with a kind of parasite or fungus, which proves fatal. With some it appears on the back, some will have a strip nearly around the body, and some about the fins and tail. This fungus is easily removed, and the skin or flesh under it has the appearance as if the spot had been blistered. Several hundred have already died, and many more are similarly situated, and, unless there is some remedy administered, all will be likely to die. We have separated the affected ones from the others, hoping to stay the spread of the disease, if it is one. Those that show no fungus appear all right and take food readily.

NOTE BY PROFESSOR BAIRD ON FUNGUS.—When the carp are taken from their winter quarters for our spring shipments there seems to be a general tendency to the development of the fungus. It is probably due to the abrasions produced in handling,

[a] In color these specimens agreed more closely with the description of *Ichthyomyzon castaneus* Girard.

the development of fungus taking place in consequence of the emaciated condition of the fish after wintering. We do not find this diseased condition in the fish taken out of the ponds for the fall and winter shipments.

I am at a loss what remedy to suggest. It is possible that you may be able to destroy it by immersing the fish for a few seconds in a brine, of course allowing them to remain but a short time, and repeating the bath several times at intervals sufficient to allow the fish to recuperate from the shock of the operation.

According to European writers the carp in Europe apparently does not enjoy the wonderful immunity from parasites and from diseases that it does in our waters. A few quotations will suffice to make this clear. Seeley (1886, p. 98) says that in nature the carp lives 12 to 14 years, but survives much longer in confinement, though "subject to many sicknesses, deformities, and wonderful variations." Veckenstedt (1880, p. 673) remarks that diseases occur mostly to young carp; "polypes render the fish unfit for its full development; tape-worms constrict its intestines, make it lean, and finally kill it; lice torment it, and produce dropsy." And on this subject Day (1880–1884, p. 162) writes:

[It] is subject externally to fungoid growths, especially old carp; also the same mosslike appearance occasionally attack young fish which reside in foul or snow water, as well as blindness, epidemic fevers, visceral obstructions due to over-gorging on chickweed, ulcerations of the liver, malignant pustules under the scales termed small-pox by fishermen, carbuncles, and intestinal worms.

This difference on the two continents is probably in large part due to the fact that the carp described by the European writers were mostly fish whose ancestors for generations back were pond-raised fish, and which, owing to their long domestication, were more susceptible to the attacks of parasites and disease. These authors do not state what is the condition in the fish of the open waters of Europe in comparison with those reared in ponds, except Seeley's statement that carp kept in confinement are more subject to "sicknesses, deformities, and wonderful variations." Neither do we know the condition in this respect of those fish imported to the United States; hence it is difficult to say whether the apparently almost complete immunity of the Lake Erie carp is due to the fact that the fish originally brought to this country were practically free from parasites, so that few have been handed on to their descendants, whether it is due simply to the free, active life of the fish, or whether there is something peculiarly favorable to the fish in the conditions of our waters. The last seems to me likely to be the most important factor—that the conditions which have allowed such a phenomenal increase in the numbers of the fish have produced a hardy strain which is more than ordinarily resistant to the diseases that normally attack the species.

Professor Prince, commissioner of fisheries in Canada, makes special point against the carp on the ground of its susceptibility to diseases and parasites, and in a paper in which he strongly urges Canadians

not to undertake its culture he has the following to say on this subject (Prince, 1897, p. 35):

German carp are especially subject to parasites and contagious diseases. From their omnivorous and lethargic habits no fish are so readily attacked by diseases and parasites as carp. The "fish leprosy," described by Blake as a fungoid growth which spreads over the whole skin, turning the fish white and rendering it most unhealthy and a source of disease to all other fish, is essentially a disease of the German carp. Frank Buckland studied some of the diseases of these fish, and among others enumerated one malady which he called small-pox in the carp.[a]

Tapeworms and other disgusting endo-parasites occur most plentifully in carp. One described by Harrington Keene taken from a carp of 16 pounds weight measured no less than 45 feet in length. Of all fresh water fishes the German carp are the most subject to external and internal diseases. This is, in fact, unavoidable in a family like the carps, with sluggish habits, a fondness for coarse and loathsome food, and a preference for muddy and almost tepid waters.

If any of the above is from Professor Prince's own observations I feel quite certain that he can not, at all events, have made them in this country. And if the German carp in Europe has been found to be subject to a number of diseases and parasites, it must be remembered that this is a subject upon which comparatively little is known in general, and that the carp, being a cultivated fish, has afforded opportunity for close study which most others have not. Certain it is that some of the fungus diseases to which he applies such awful names will attack almost any fish or other water animal under conditions unfavorable to the latter, and especially if there happen to be any abrasions of the integument. The carp's hardiness in this respect is one of its chief characters, allowing of its cultivation in ponds and small enclosures, conditions under which many of our native fish would succumb to fungus and other diseases in a short time. Then, too, contagious diseases, strictly speaking, are, according to present knowledge, extremely rare among fish, and I am not aware that any has yet been found which attacks the carp. The whole tone of Professor Prince's paper leads us to suspect that if he were studying a fish malady he would call it by some such name as smallpox in carp, whatever title he might use to designate it in other species.

It remains now to consider certain enemies which menace the fish, especially those which may attack them while they are in the ponds. These are in reality very few in such ponds as are in use in this country, since the impounded fish are all adults, and the adult carp has comparatively few serious natural enemies. With the young fish it is different, and the regular carp culturist has, of course, to deal with all these factors. The eggs are exposed to a great number of dangers, and especially are they open to the attacks of minnows and other small

[a] The disease here referred to is apparently due to one of the Myxosporidia called by Hofer (1896, 1896*a*, 1896*b*) *Myxobolus cyprini*. This appears to be not uncommon in European carp ponds, but I am not aware of its ever having been reported on the carp in this country. I have not had opportunity to examine the recent handbook of fish diseases by Hofer (1904).

fish. It is a common statement, too, in books on the subject, that frogs are very destructive to the spawn and even to the young fish.[a]

Walton (1901 ed., p. 115) even believes that frogs sometimes attack the adult carp, and after speaking of the mysterious disappearance of carp from ponds, relates the following curious story in defense of his belief:[b]

And the like I have known of one that had almost watched the pond, and, at a like distance of time, at the fishing of a pond, found, of seventy or eighty large Carps, not above five or six; and that he had forborne longer to fish the said pond, but that he saw, in a hot day in summer, a large Carp swim near the top of the water with a frog upon his head; and that he, upon that occasion, caused his pond to be let dry: and I say, of seventy or eighty Carps, only found five or six in the said pond, and those very sick and lean, and with every one a frog sticking so fast on the head of the said Carps, that the frog would not be got off without extreme force or killing. And the gentleman that did affirm this to me, told me he saw it; and did declare his belief to be, and I also believe the same, that he thought the other Carps, that were so strangely lost, were also killed by the frogs, and then devoured.

And a person of honour, now living in Worcestershire,[c] assured me he had seen a necklace, or collar of tadpoles, hang like a chain or necklace of beads about a Pike's neck, and to kill him: Whether it were for meat or malice, must be, to me, a question.[d]

Among the other enemies to the young may be mentioned all the larger carnivorous fishes, turtles, water snakes, certain aquatic birds, especially the herons, and a few of the fish-eating mammals. Of the mammals, the only one that has to be especially guarded against in the ponds of this region is the muskrat, and that not because of any harm it does directly to the fish, but from the fact that it burrows through the embankments, causing leaks which may seriously lower the water level before discovered, and weaken the embankments themselves. Undoubtedly there must also be included among the enemies to the fish certain waterbugs, such as *Belostoma* (commonly known as the "electric-light bug") and *Ranatra*. An account of the ravages of these insects is given by Dimmock (1887), who quotes (page 69) the following letter, dated December 16, 1886, from Mr. E. A. Brackett, of Winchester, Mass. chairman of the Commission of Inland Fisheries of Massachusetts:

In October last, while drawing off the carp-pond, the water became very roily, and I noticed several young carp moving on the surface, sidewise, evidently pro-

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[a] Miss Mary C. Dickerson, of the Rhode Island Normal School, who has had much experience in keeping and observing our native frogs, has kindly sent me the following opinion as to the extent to which the North American species of frogs might prove injurious to fish ponds:

"Frogs would prove a menace to fish ponds, i. e., if in large numbers and if they were the aquatic frogs. We have only one in the East that would do any damage, that is *R. catesbiana*, our common bullfrog, although there is one other, *R. clamata*, that will feed on fish to some extent if there is not a large supply of air and surface-water insects. In the West *R. pretiosa* is wholly aquatic, i. e., it takes its food from under water. All of our other frogs (some 9 kinds) would be quite harmless. They spend very little of their time in the water and do not take food from below the surface. My conclusions are from several years of laboratory feeding experiments."

[b] In a paper which has appeared while the present report was in press Gill (1905, pp. 208, 209) quotes from other observations, which lend further credence to the belief that frogs, and toads as well, under the influence of sexual excitement, may attach themselves to fish in the manner described.

[c] "Mr. Fr. Ru." [Walton's original footnote.]

[d] Day (1880-1884, p. 162) quotes another and similar case from Pennant.

pelled by some external force. With a dip-net I took these young fish out, and found that in every case they were firmly held by a water-bug. The fish were dead, and the bugs apparently had been feeding on them. I had no means of determining how many of these bugs were in the pond.

Dimmock gives several references to literature on the same subject, and in the report of the United States Fish Commission for 1894 (1896, page 36) it is stated that carp in the ponds at Washington suffered from attacks of *Notonecta* and *Nepa*. As has been said, however, there is little to be feared from natural enemies in the temporary ponds and pens as they are conducted in this country, the greater dangers arising from impurity of water and other physical conditions.

ECONOMIC RELATIONS OF THE CARP.

Under this heading it is proposed to consider the relation of carp to aquatic vegetation, and to other fish and their spawn, as well as the secondary questions arising from these. The discussion is, for the most part, an examination of the numerous charges that have been made against the fish as to the damage it does, and in this respect is distinct from the succeeding chapter, which discusses the uses to which carp are and may be put. In Europe the mass of the literature on carp relates to its culture, but in this country it is safe to say that more has been written on the present subject than on all the others together. It has occupied our newspapers, our periodicals, and our scientific proceedings. Although so much has been written and said, however, this is nevertheless the subject on which perhaps the least is definitely known; the latter fact is probably an explanation of the former. Many extravagant statements have been made on the one hand as to the value of the carp, while on the other the English language has been searched to find words strong enough for its condemnation.

This state of affairs has, I believe, a very simple explanation. When the fish was introduced, the impression became prevalent that if one obtained a few carp, dumped them into any hole containing a little water which he chanced to have or could construct on his land, without further care he would always have a bountiful supply of excellent fresh fish. As recently expressed at a meeting of the American Fisheries Society, "almost every farmer had a carp pond in his front yard, back yard, or barnyard, or somewhere." These expectations were far in excess of what was ever claimed for the carp by its introducers, and it is little wonder that the people were disappointed. As it was seen that the ponds did not yield the phenomenal results expected, and as the novelty wore off, they were left neglected and uncared for, so that within a short time, through the agency of freshets and the undermining of embankments, the fish had gone to help stock the public waters in all parts of the country. For a time after this, comparatively little was heard of them, except that in local lists of fishes they grad-

ually began to be included as becoming common. But in many localities in recent years there has been an alarming decrease in the number of waterfowl, game fishes, and in many cases commercial fishes as well, and gradually the blame for much of this has been shifted upon the carp, which in the meantime has become the most abundant fish in some localities. Whether the blame was rightfully placed or not, remains to be seen. The game and food fishes seemed to be decreasing, the carp were undoubtedly increasing, and to many minds the inference was plain. It is a curious fact that those who are most concerned in the decrease of the fish and game are often the last to see that they themselves might in a measure be the cause. They are looking elsewhere for the explanation, and when a possible factor presents itself it is at once seized upon and made to bear the brunt of the whole charge. This is the point that I wish to emphasize here—that most of the statements that have been made as to the damage done by carp have been based upon very insufficient evidence; if founded upon direct observations at all, they were observations that, if not inaccurate, were at least inadequate. At best the evidence has been circumstantial, while on the other hand the defense has been either simply negative, or in places the attempt has been made to vindicate the carp on the grounds of its usefulness.

The denunciations of the carp have been so numerous, and in many respects so similar, that only a few quotations need be given to show their tenor. The specific charges based on direct evidence, so far as I have been able to find them, will be dealt with in more detail. What I shall attempt to do is to sift the evidence in as careful and impartial a manner as possible, adding to it what I have myself been able to learn in the prosecution of my studies on the subject. The best recommendation I can bring forward for myself as a juror in the case is that I approached the subject with little knowledge of the particular question, and, consequently, "unprejudiced and without previously formed opinions."

It should be borne in mind that direct observations bearing on the various phases of the question as to the damage done by a fish like the carp are very difficult to make, and are in most cases largely matters of chance, while at the least they require a great amount of time. Take for example the relation of the carp to the black bass. The question is often asked, "Will a carp drive a black bass from its nest and devour the spawn?" If a person by chance happens to see the thing done, and is certain that he has interpreted his observations aright, there is the proof of the matter, and so it is settled. On the other hand, one might watch a bass nest for a long period—say, many hours each day—and never see a carp come near it, but one would still have no proof that it might not do so—his evidence would be only negative. To be sure, the longer the observation was continued the greater would

be the probabilities in favor of the harmlessness of the carp; but it seems to me that in most of these charges of destructiveness the burden of proof must rest with those that make the charges. If, however, in the case supposed above, the watcher should see a carp come near and be driven away by the bass, this would be good direct evidence in the carp's favor. All this serves to emphasize the importance of taking advantage of whatever opportunity chance may offer to throw light on these questions.

The principal charges that have been preferred against the carp have been enumerated in a preliminary statement of the present investigation (U. S. Fish Commission Report, 1903, p, 129) as follows:

(1) That the carp thrashes about and stirs up the mud, so that the breeding grounds of other fish are spoiled; (2) that the carp roots up the vegetation, destroying the wild rice, etc., and thus ruining good duck-shooting grounds; (3) that the carp eats the spawn of other fish; (4) that the carp eats the young of other fish; (5) that the carp is of no value as a food fish; (6) that the carp is of no value as a game fish.

To the first of the above might be added the charge that in stirring up the mud of supply reservoirs of water that is used for drinking purposes the water is made unfit for use. The first four of the charges will be considered here, the fifth and sixth will be discussed in connection with the food value and uses of the carp.

RELATION OF THE CARP TO VEGETATION.

The principal complaint against the carp on account of its destructiveness to aquatic vegetation comes from sportsmen, especially the duck hunters. They are almost unanimous in their condemnation of the carp on this account, but conversation with a number of them soon makes it apparent that while some are speaking from personal experience, and the opinions given are their own, many are merely repeating statements which they have heard, and which have become so stereotyped that they are easily recognizable to one who is investigating the subject. It so happens that the St. Clair Flats, and more especially the marshes bordering Lake Erie, are among the most famous duck-shooting localities in the Middle West, so that in this connection I shall confine myself for the most part to inquiries made there.

The most definite information I obtained as to the changes that have taken place in the aquatic vegetation in the last decade or so was near the mouth of the Sandusky River, where it opens into the bay of the same name. Mr. Fitzgerald, the keeper at the Winnows Point Club, who has lived in the region all his life, not only told me of the changes in the conditions as he could remember them, but allowed me to examine the records of the club in further substantiation of his observations.

It appears that the first carp were brought to that immediate vicinity in 1883 by D. W. Cross and Colonel Scovill, of Cleveland. A small pond was prepared near the clubhouse and, according to the records,

on May 20 was awaiting the arrival of the fish. These probably came soon after and were put into the pond on or before the morning of the 21st, for on that day there was a severe storm, the pond was flooded and finally broke out at 2 p. m., and all the fish escaped. The lot consisted of 20 leather and 20 scale carp. Later a large lot of young carp were sent to the club and were liberated in the marshes by Mr. Fitzgerald's father, and still more were planted by a tug which went up the river, putting in carp at various places along the route. To-day these fish are extremely abundant in this locality, and have been so for a number of years.

According to Mr. Fitzgerald's statement, coincident with the increase in the carp there has been a great decrease in the amount of wild celery (*Vallisneria spiralis*) growing in the shallower waters. He says that formerly, in late summer, the strip of comparatively shallow water extending some quarter to one-half mile from the clubhouse to the main channel of the river was thickly grown up with this plant. Its leaves were so abundant, floating on the surface of the water, that it looked almost like a solid bank, and it was only with great difficulty that a boat could be paddled through it. To-day this stretch is open water; only here and there do a few lily pads come to the surface. Much the same thing had been told me the previous summer by a carp fisherman, who for many years has acted as guide for hunters in the region. He affirms that the marsh has changed greatly in the last few years, and believes it is due to the carp. He says the carp root up principally the wild celery (*Vallisneria*), wild rice (*Zizania*) and deer-tongue (probably meaning both *Sagittaria* and *Pontederia*); and that the "canvasback celery" (*Vallisneria*) has been largely cleared out.

At the same time the duck shooting is said to have been rapidly on the decline. The canvasbacks (*Aythya vallisneria*) and redheads (*Aythya americana*) especially have been growing scarcer and scarcer. The records of the Winnows Point Club, mentioned above, show a very marked falling off in the number of canvasbacks killed in about 1893, and conspicuously so in the numbers of both species in 1898–99. This is ascribed to the "absence of food." Since 1899–1900 not more than three or four canvasbacks have been killed by the members of the club each year. It is the custom now to sow wild-rice seed in the vicinity, but I do not know whether this has yet proved to be beneficial.

In order to learn something of the conditions and the sentiment of the sportsmen in the western part of Michigan, where there are many famous duck marshes, I sent a circular letter to the postmasters at Muskegon, Grand Haven, Holland, Saugatuck, and South Haven, and in each case received a reply either from the postmaster himself or from some one to whom the letter had been referred by him. The verdict from Saugatuck, on the Kalamazoo River, accorded very closely with that from Lake Erie. Mr. Charles E. Bird wrote that they have

no wild celery, but do have much wild rice. Since the carp have been planted, however, this has been largely rooted out; "they dig it up like a drove of hogs, and have about spoiled the marshes for ducks."

Mr. C. J. Dregman, of Holland, writes that carp are abundant in the lake (Black) and river there, and adds:

As to their destructiveness to wild celery or otherwise I have no reliable information to give you. There is comparatively little wild celery here, and that which does grow here seems not to be affected from year to year. Common report has it, however, that carp are destructive to fish eggs and nests.

Mr. George C. Monroe, of South Haven, does "not believe they cause any damage to plants along the river bank." At Muskegon, according to Mr. E. D. Magoon, "the marsh is full of channels and bayous, and these abound with carp." Wild celery, rice, and other duck food are found here, but he expresses no opinion as to the effect of the carp on these.

Considerable valuable testimony on the question under discussion is given by Doctor Smith in his report on the acclimatization of fish in the Pacific States (Smith, 1896, pp. 393-403). Several cases are mentioned where carp are reported as destroying the vegetation, most notable among which are observations made at what are known as the "Suisun Marshes." Doctor Smith (p. 397) quotes a letter from Mr. Ramon E. Wilson, secretary of the California Fish Commission, dated November 12, 1891, which states that certain portions of the marshes referred to above have been preserved by five shooting clubs for a period of ten years previously. The letter continues:

Each of these clubs has, from year to year, supplemented the natural and indigenous growth of vegetation by planting non-indigenous seeds and grasses, until about two years ago the ponds, ditches, and sloughs had so grown up with vegetable matter that upon the opening of the season it was almost impossible to push a boat through the dense growth. Last year, the season of 1890, it was discovered that a marked change had taken place. The cause was attributed to the winter, which was a rather severe one, in that there were many overflows and freshets occasioned by heavy storms. This year the change in the respect mentioned was much greater. It was early reported in the spring that there was very little sign of vegetable growth in any of the ponds. Investigation followed, and it was found that fish in large numbers, ranging from a few inches in length to 15 pounds in weight, had invaded the grounds and taken entire possession of all the waters. These fish came, say, in May and remained until about the latter part of July—that is, the bulk, but many remained later. We are convinced that these great numbers came to spawn. About August this great school, if you can so call it, suddenly disappeared—that is, the larger ones and the majority of the whole. Their going was not unlike the grasshopper in effect on vegetation—not a sign or remnant was left. The result is that to-day, where these same ponds have heretofore afforded unlimited food supply for surface-feeding ducks in the early part of the season and a like supply of celery bulbs for the canvasbacks and redheads for the balance of the season, there is absolutely not a single sign of vegetation. At the time mentioned I carefully examined the beds of the ponds and found them positively barren of vegetable matter. Notwithstanding the emigration, if it can be so called, of the larger fish, the waters are still alive with the same fish, ranging from 2 to 8 inches in length. These ponds, heretofore quite clear, are now nothing

more than mudholes. That this fish burrows in the mud there is no question. The beds of the waters are not unlike a sieve in appearance, with holes, round in form, ranging from one-half inch to 3 inches in diameter. The banks of the ponds and sloughs are quite like the bottoms. The fish have burrowed to the depth of a foot in many places, and it can be readily seen that it has been done for the purpose of getting at the roots of the vegetable growth.

That the fish which caused these disturbances were carp Mr. Wilson determined by sending specimens to Dr. David S. Jordan.

The testimony of Mr. John P. Babcock, at that time chief deputy of the California Fish Commission, is very similar. He is quoted as follows (Smith, 1896, p. 399):

The carp have destroyed almost all the wild celery of the lower Sacramento and Suisun Marshes. They reach all the ponds during high water, and, as soon as celery comes up, they eat the shoots, and, in many of the best ponds on the shooting preserves, have taken roots and all of the celery. They have not destroyed the tule grass to any noticeable extent, if at all. The damage has been to the better grasses. Many of the clubs planted wild celery in 1891, 1892, and 1893, but the carp destroyed it all, and it is claimed by observing men that the celery is entirely destroyed. The clubs resort every season to baiting their ponds with grain, and in these ponds the carp move in droves that W. P. Whittier tells me look like a tidal wave, as they move from one side to the other.

The most extravagant charge as to the damage done to vegetation by carp which I have seen is given by Prof. E. E. Prince, commissioner of fisheries for Canada, in a paper discussing "The Place of Carp in Fish-culture" (Prince, 1897). He says (p. 33):

In connection with this charge, a western United States paper tells of a rancher's visit to Portland, Oreg., to sue for damages he had sustained from the introduction of carp. He wished to find out whether he had recourse against the United States Fish Commission for the introduction of carp into the rivers of this section. He says these fish are destroying his meadows by eating his grass and grubbing up the roots. As the water overflows his meadow the carp follow it up in thousands, the small ones weighing about 3 pounds pushing their way up where the water is only 3 inches or so in depth and clearing off all vegetation, so that when the water recedes he will have mud flats in the place of meadows.

This statement appears the more credible, however, in view of some remarks made by Doctor Hutchinson, stationed at Portland, Oreg., in a letter discussing the value of the carp as an eradicator of the fluke disease of sheep. Doctor Hutchinson says (Stiles, 1902, p. 221):

All the bottom lands of this river [the Columbia] are subject to annual overflow, and at this time the carp clean the meadows as thoroughly as a fire. Every spear of grass, up to the very water's edge, will be eaten by them. They also have a habit of rooting all around the edge of this overflow as it gradually recedes.

Mr. Hessel, in reply to the letter from Mr. Wilson regarding the damage caused by carp in the Suisun Marshes (Smith, 1896, p. 400), states it as his opinion that the carp are in search of worms, crustacea, larvæ, etc., when they dig about the roots of the plants, and that the uprooting of the plants themselves is merely incidental. According

to him the aquatic vegetation in the Potomac River has not been damaged by carp, although these fish are abundant there. He says:

The carp is very numerous and prolific in the Potomac River. There are specimens from 20 to 30 pounds, but that they go for the water celery has not been noticed here as yet. Water celery grows in abundance in places where the river flows slowly, especially about the so-called flats, but any injury to its growth, or a reduction of its density, not to speak of its total destruction, has not been heard of, as far as I know, with two exceptions only, not attributable, however, to the carp, but to high water in the spring of 1882 and 1889, when every kind of vegetation was swept away by the floods, and consequently water celery disappeared from the river during the two years subsequent to those freshets.

I must not forget to call your attention to the fact that turtles, too, are not averse to a meal of water celery. Frequently I have seen "red-bellies" and "yellow bellies" feasting in the dense growth of Potomac celery upon that plant. Another point: For years I have kept quite a number of these species of turtles for ornamental purposes in a small pond about this station and fed them with water celery taken fresh from two ponds stocked with a great number of old and young carp, which never touched the celery, though it must be admitted they did loosen the roots in their hunt for animal food.

In conclusion, I reiterate that I am not familiar with the fauna of the Suisun Marches, but my impression is that, upon closer investigation, there may perhaps be found additional causes for the disappearance of the water celery and other vegetation therein, besides the undeservedly much-abused carp.

Even if Mr. Hessel's contention that the uprooting of the plants is a secondary result as the carp is searching about in the mud for animal food should be found to be true, the nature of the damage done would be the same. It seems, however, from the facts brought forward in the discussion of the food of the carp, that we should not be too hasty in concluding that it is altogether for animal matter that they dig up these plants; knowing as we do that they eat a large quantity of vegetable matter, it seems likely that they would take it whenever there is opportunity, so that in the case of the wild celery they probably eat the softer parts of the plant as well as the crustacea, insect larvæ, etc., dug up in the mud.

The fact that the wild celery in the Potomac was not being destroyed is a matter of more weight, but if the damage in other places is really perpetrated by the carp it merely goes to show that under certain conditions the fish does not harm the vegetation to a marked extent, while in other cases it does. This perhaps depends upon the relative abundance of other food. Furthermore, as Mr. Hessel suggests, there should be further investigation as to whether the carp is the sole factor in causing the rapid disappearance of these water plants. It must be remembered that we know very little of the obscure ecological forces at work which may cause great changes in the aquatic flora of a region. Since these reports come from such widely separated areas, however, the factor which is causing the destruction must be a very general one. If the damage were confined to the Great Lakes basin, for instance, it might be expected that some general phenomenon, such as a gradual

lowering of the water level in the basin, might be the cause, though it is difficult to see how that particular factor, even if it could be proved to exist, would effect the vegetation as has been observed. It would be expected as the result of such a lowering that the different floral zones would not in most cases be destroyed, but would merely reestablish themselves a little farther out from the original shores. Since a similar decrease is being complained of in many parts of the country, however, and within comparatively only very recent years, we would expect to find the same cause in all cases, and would look for some new factor coincident with the trouble. The planting and astounding acclimatization and propagation of carp seems to have introduced such a factor.

Then, too, there must be examined the more direct evidence against the carp. Vegetation has been rooted out of comparatively small ponds and reservoirs, where close observations could be made, and where apparently the only change in conditions that could account for it is the introduction of carp. And, finally, we know that these fish do root up many plants. In a pond where the carp were feeding in large numbers I have seen the surface of the water quite well covered in places with the uprooted vegetation, among which were to be seen whole plants of flags torn out bodily. In other places, when the *Vallisneria* was still young and did not reach nearly to the surface, I have observed the leaves floating about, recently torn from the bottom. Although it could not be determined with certainty in this case, it is very probable that carp were responsible. The roiliness of the water at the place served to strengthen the suspicion.

One can not be too careful, however, in drawing conclusions of this kind, since there are many opportunities to make mistakes. A concrete example may serve to illustrate the point. I was wading about in a little bay at the St. Clair Flats, where carp were abundant, and noticed many freshly torn up leaves of flags floating on the surface. It looked very much at first as if this were the work of the carp, but I later saw the agency at work—a muskrat, which dived to the bottom, cut off a leaf and brought it to the surface, floated there while he ate the succulent lower end, and then left it, to go down after another. These leaves were bitten off singly, however, while the flags mentioned above as uprooted by carp were torn up roots and all, probably not so much on account of direct pulling as by having the mud worked away from around the roots.[a] The male dog-fish (*Amia calva*)

[a] Unfortunately it was found inexpedient to make an experimental test of the effect of carp upon aquatic vegetation. This could be done by having two similar ponds or enclosures in which conditions are as nearly the same as possible. Into one of these should be introduced a certain number of carp, while the other should be left without them. If this were done in the spring, for example, an exact comparison could be made of the conditions in the two areas as the season advanced. The greatest caution should be taken in seeing that all conditions, except the presence of the carp, should be the same in the two enclosures.

also cuts off the young shoots when building its nest, and at such times these may be found floating on the surface of the water.

In conclusion, as to the relation of carp to aquatic vegetation, the evidence seems to be pretty strong that in general they are very destructive, and are probably, in large part at least, responsible for the great reduction of wild celery and wild rice that has been noted in many of our inland marshes in the last few years. This, in turn, has deprived certain ducks, especially the canvasback and redhead, of an important food supply, and has undoubtedly influenced their abundance to some extent in the localities in question. Whether the great reduction in their actual numbers can be laid to this cause is a very different question; and when we observe that the same complaint is being made of nearly all game birds and mammals not rigorously protected by law, it makes us look for an influence at work more general than the introduction of carp into our waters. Such an influence is to be found in the hunters themselves, and must be reckoned with in the case of the ducks as well as elsewhere. Whether it is more or less potent than the reduction of one of their sources of food is a question which remains to be settled. It is possible, too, that with the development of the country, and especially the opening up of extensive areas by irrigation, the ducks, instead of being actually so decreased in numbers as would at first seem to be the case, have scattered to new feeding grounds. A portion of the following quotation from the paper by Smith (1896, p. 399), mentioned above, refers to this possibility, while it also sums up in a concise manner the other aspects of the question:

> In attributing to the carp the scarcity of canvasback and other ducks in a given region, there should be proof that the carp does and other fish do not eat and uproot large quantities of *Vallisneria;* and the influence of market hunters and indiscriminate killing by sportsmen must not be overlooked. The scarcity of canvasback ducks in most streams probably antedates the advent of the carp in noteworthy numbers, and, as in the Potomac, was coincident with spring shooting and with the activity of pot-hunters using swivel guns. Mr. John P. Babcock, chief deputy of the California fish commission, states that he thinks ducks in that State have changed their feeding grounds; miles of land in the San Joaquin Valley are now covered with ditches and miles of alfalfa now grow where a few years ago there was a desert; and the main market supply of ducks comes from that region instead of the Suisun Marshes. He thinks, however, that the carp have proved very objectionable in this region.

In consideration of all the evidence set forth above, although we are obviously unprepared to say to what extent, we seem forced to conclude that carp are, in some measure, detrimental to certain species of ducks.

ROILINESS OF WATER INHABITED BY CARP.

The extent to which carp stir up the bottom mud and make the water roily has been mentioned in speaking of its habits, and especially its manner of feeding. As a general thing this is one of the surest indications of the presence of these fish in waters that would otherwise be

clear; and it has several rather important economical bearings besides the mere fact that it usually accompanies or is accompanied by the uprooting of the aquatic vegetation. The constant roiliness of a body of water that has theretofore been clear must be an important ecological factor in determining the quantity and character of both the vegetable and, at least secondarily, the animal life inhabiting it. This will readily be appreciated when we consider that it decreases the amount of light that would reach to any given depth, thus depriving plants at that depth of at least a part of one of the most important conditions for their growth, while in the second place the settling of the sediment upon the stems and leaves of the plants acts as a mechanical hindrance to the ordinary processes of respiration. Where the balance is once upset in this way in a body of water where things have become adjusted to a certain set of conditions, it is difficult to predict just what results will follow in the readjustment to new conditions; but it is safe to assert that practically all the living organisms in the water will be influenced to some extent. Even if the vegetation were not uprooted by the stirring up of the mud of the bottom, it is probable that its abundance would be greatly reduced by the constant roiliness of the water. This would in all likelihood affect the plankton or free-swimming organisms as well, and thus greatly reduce the natural food supply of the fish. In the large bodies of water these conditions are ameliorated to a large extent, since by the movement of the fish from place to place they are often absent from a given locality for considerable periods, thus giving the sediment an opportunity to settle and allowing the water to become clear; and even in smaller areas the fish are not feeding all the time. But it must be admitted that where there are a comparatively large number of carp in a pond the water is kept in an almost constant state of roiliness. In the case of running waters there is a further tendency to impoverishment in the carrying away of the rich mud while it is held in suspension in the water. There has been no direct evidence collected, so far as I am aware, to show to what extent this may be effective. It has even been claimed by some that dikes and dams are weakened in this way, by the destroying of the vegetation that held the mud in place, and the loosening of the mud itself.

The roiliness of the water caused by carp in supply reservoirs has, in a number of instances, proved to be a serious problem, and is one which has to be met with promptness. The only practicable remedy is the removal of the fish. In some places this can be done with comparative ease by persistent seining; but more often, especially in large reservoirs which present a diversity of conditions, this method is not feasible. In some cases it may even be necessary, where the disturbance is very great, to withdraw the water and drain the reservoir for the purpose of getting rid of the carp. An interest-

ing case of the way this problem was met in Lake Merced, one of the reservoirs for the water supply of San Francisco, is reported by Smith (1896, p. 395) in the paper that has already been quoted. A number of sea lions put into the lake apparently did the work very efficiently; but unfortunately this is not a method that it is always possible, or at least, practicable, to apply. Doctor Smith quotes Mr. Babcock, of the California Fish Commission, as follows:

> Carp have entered the Blue Lakes in Lake County. The Blue Lakes, three in number, were formerly very striking and beautiful bodies of water. A. V. La Mott now tells me that lower Blue Lake is so muddy that its beauty is gone, the carp keeping the water roiled all the time. Lake Merced, property of the Spring Valley Water Company, in the city and county of San Francisco, was so damaged by carp as to be almost useless to the company. The company employed four fishermen by the month to seine the lake, and during that time—some four months—bought 19 good-sized seals [i. e., sea lions] taken near Cliff House. These seals were placed in Lake Merced in 1891, and for a time the company employed men to go over the lake to pick up the pieces of dead carp that were so numerous as to be dangerous to the purity of the water. In the summer of 1895, at the request and expense of the water company, I engaged several Italian fishermen to go to the lake, and under our supervision they used all kinds of drag nets and seines in the lake and were unable to take any carp or any other fish than sticklebacks. The seals have grown very thin. Another effort was made in same manner with like results in the fall of 1895. I am of the opinion that there are no carp, big or little, in the lake at this time. The coming season the company will try again for carp, and if none is found the seals will be killed off and large-mouth black bass placed in the lake.

The planting and maintaining of large predaceous fish in waters where carp are objectionable will undoubtedly help to a large extent in keeping their numbers down, as they will prey upon the young carp. It is doubtful whether they will be of much effect in removing the larger fish, however.

Another point is mentioned in the above quotation which is often one of considerable importance, namely, the marring of the beauty of lakes and other bodies of clear water by carp, by keeping the water constantly muddy and roily. This is a problem which is apt to be encountered by park commissioners, and is to be met in the same way as in the case of the reservoirs. In parks, however, the usefulness of carp as a source of interest to visitors, who take pleasure in feeding them, may be considered as offsetting their undesirability in other respects, though gold-fish are usually preferred on account of their more showy appearance.

RELATION OF THE CARP TO OTHER FISH.

Perhaps more complaint has been made against the carp by anglers and commercial fishermen for its alleged destruction of other fish than by the sportsmen for its harmfulness to the feeding grounds of ducks. These complaints have come from nearly all quarters, and it will usually be found that they arise from a general sentiment rather

than from definite information. It is a noticeable fact that this sentiment is much less general, or may be largely replaced by one almost as unreasoning in favor of the carp's entire harmlessness, in regions where this fish is commercially valuable on a large scale. The charges may in a general way be divided into four headings: (1) That carp eat the spawn of other fish; (2) that carp eat the young of other fish; (3) that carp prevent the nesting of such fish as the basses; (4) that carp produce unfavorable conditions—chiefly roiliness of the water—that drive other fish away.

In the Great Lakes region the fishes that are generally conceded to be in most danger from the carp are the bass and other members of the same family (crappie, sun-fish, bluegill), and the white-fish. It is obvious that they can hardly affect directly such other commercial and game fishes as the wall-eyed pike and sauger (*Stizostedion*, commonly called "pickerel" on the Great Lakes), or perch[a] (*Perca flavescens*), or trout; nor do I know of specific complaints of damage to the herring (*Argyrosomus*), sturgeon, or the true pikes (Esocidæ, "pickerel" of the inland waters). Most of these do not lay their eggs where they are likely to be troubled by carp, and some are probably considered able to take care of themselves. Still it seems that carp might easily affect wall-eyed pike, in cases where the eggs are attached to water plants; and if they affect white-fish they probably also affect herring, whose eggs are laid at the same time and presumably in the same places.

The first of the complaints enumerated above, viz, that carp eat the spawn of other fish, is perhaps the one that has been most persistently maintained. One can scarcely read a communication by one of the opponents of the carp without finding in it a statement to that effect. Nevertheless, few, if any, direct observations are recorded. The argument is something like this: Other fish, such as the bass, are decreasing, while the number of carp is, or at any rate has been, steadily on the increase; carp will eat practically anything; therefore, the decrease of certain other fish must be due in large part to the fact that the carp devour their spawn. What I wish to point out is that while the two premises may be true, the conclusion is by no means a necessary one. It can not be deduced from the above premises without other facts, and those facts have not been supplied. They might be of two kinds—first, direct observation of the eating of the spawn of other fish by carp; and, second, by the finding of the spawn of other fish in the

[a] With regard to the perch, at the thirtieth annual meeting of the American Fisheries Society both Mr. Dickerson, of Detroit, and Doctor Parker, of Grand Rapids, Mich., expressed their opinion that the carp is indirectly harmful to the perch through the destruction of the vegetation. Doctor Parker remarks (Transactions of the Society, 1901, p. 124): "You must go back to the vegetable for the rehabilitation of waters. If you destroy vegetation and the larvæ, you destroy the minnows, and the perch have no minnows to feed on, unless they can eat the young of the carp, which they do not appear to do, but the black bass will eat the young of the carp and will thrive. Therefore you may look for an increase of the black bass, a decrease of the minnows, and also of those fish that feed upon the smaller minnows."

stomachs of carp. Although it is stated that carp do go about over the spawning grounds of other fish and that they devour the spawn, with the exception of the little given in this paper relative to the white-fish, I do not recall a single case that has been reported upon where sufficient evidence has been adduced to show that such is really the case. The absurdity, for example, of an assertion which has recently been made by a writer in Forest and Stream (Chambers, 1904) is obvious on the face of it. This partisan, after deprecating carp as a food fish and speaking of its habit of uprooting wild rice, adds:

> When the stomach of one caught upon the St. Clair Flats was opened last autumn, it was found to contain at least a double handful of rice, while as an illustration of their destructiveness upon the spawn of other fish it may be mentioned that *a gallon of spawn* which had been devoured was taken from an 18-pounder—a weight which the carp frequently attains.

The italics are mine. The enthusiasm of partisanship has apparently led this observer into mistaking the spawn of the carp still in the ovary for that of some other fish which has been devoured, for it seems altogether out of the question that the stomach of one 18-pound carp should hold a gallon of spawn. A double handful of rice—wild, or Indian, rice (*Zizania*), I suppose is meant—might well be present. The greatest amount of material which I have ever taken from the alimentary tract of a single carp would surely amount to much less than a pint, though I can not say that by distention it might not hold more.

In my own researches at the St. Clair Flats, where the black bass were nesting in numbers, I spent much time in attempting to get direct evidence relating to the question at issue. Most of these observations were made in a small bay where the general water level in the deeper parts was about 3 to 5 feet. The bottom was composed of a fine clay, in most places rather light in color. Practically the only vegetation in this portion of the bay consisted of scattered groups of bullrushes, each clump usually radiating in long lines from a common center. The bass[a] nests were in this open part of the bay, large circular excavations, a few inches deep, and usually appearing much darker than their surroundings on account of the removal of the top soil. As a rule they seemed to be placed near the lines of bulrushes, and were usually plainly distinguishable for a considerable distance on account of the clearness of the water.

Conditions about the margin of the bay were entirely different. Here the shallow water, 1 to 2 feet or so deep, was thickly grown up with vegetation—flags, sedges, lily-pads, etc.—and was succeeded by wet, marshy, grass-covered ground. The bottom here was largely

[a] I believe these were the small-mouthed black bass (*Micropterus dolomieu*), though I find no record of the species made at the time.

soft, and black on account of the decayed vegetable matter. In this shallower area all about the bay carp were often very numerous.

In the first place much time was spent in trying to learn whether the carp ever intruded in the central portion of the bay where the bass were nesting. It seemed very probable that they would cross the bass nesting-grounds, at least in going in and out of the bay. But I was never able to observe a single carp actually on these grounds, though I at one time frightened a number of them in near shore which started out in that direction. A fyke-net was set with a view to intercepting any carp that might cross the tract covered by the bass nests, but with negative results. These fish are so wary, however, that it is very doubtful whether they would have entered the net had they gone that way. At another place I at one time had a large minnow seine drawn over a portion of bottom where a few bass were breeding and where I had reason to suspect there were carp present. Besides the small fish captured the seine brought in a bass, a pike, and two carp, which seems to show that they may at times go in close proximity to the area covered by the breeding bass, if not actually upon it.

In the bay mentioned above I built a scaffold at the border line between the bass grounds and the shore zone, with the idea of having a more commanding view of portions of both. On this I spent many hours of vigilant watch, and although a bass which had a nest near by soon became accustomed to the structure and resumed his care of the eggs in the nest, and although carp sometimes appeared within my range of vision in the water on the shoreward side, I never saw one of them on the outer side, where the bass nests were located. Since I have frequently seen schools of these fish lying quietly in water which seemed to present the same conditions, except that the bass were absent, I feel justified to some extent in concluding that as a general thing carp avoid the actual breeding areas of the bass.

The question has often been raised, and has been much discussed, as to whether a black bass would drive a carp away from its nest. A number of opinions were expressed on the subject at the thirtieth annual meeting of the American Fisheries Society, held at Milwaukee in 1901 (see the Transactions of that meeting, published in the same year, pp. 114–132). It appeared to be the consensus of opinion of the gentlemen assembled there that the bass is fully able to take care of itself, while it was further claimed by some that the bass were actually increasing owing to the extra supply of food furnished by the young carp. Below are given some extracts from the discussion referred to:

Mr. Titcomb. Is it not a base slander upon the bass to intimate that it would allow a carp to touch its spawn?

Doctor Bartlett. I should think so.

Mr. Bower. I think that where bass and carp inhabit the same water it is natural that the bass should increase. We have been hatching black bass for a number of seasons in ponds where we have had an opportunity to observe their spawning

operations from the time the male fish begins to prepare the bed until a good many days after the hatching is completed, and we know that the male bass guards the bed against all intruders. He will put up the stiffest kind of a fight against any animal that approaches the bed with a view of preying upon the spawn. There is no danger of a carp ever looting the spawn from a black bass bed. On the other hand I do not think the carp can retaliate against the bass in any way, shape or form. While the bass is preying on the carp, the carp can not come back at them in any way. In other words, in the interchange of hostilities between the two species, the bass gets the better of it at every stage of the proceedings, and I think it is a perfectly natural result that the bass should increase in waters where there is an abundance of carp.

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Mr. LYDELL. I never have known but a single instance where the carp has destroyed the spawn of the black bass, and I never knew of their destroying any other spawn. I have handled and opened what few carp were caught at the Detroit river, Belle Isle, fisheries, during the last ten years, but never found any spawn in them.[a]

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The PRESIDENT [Mr. DICKERSON]. I have made this assertion, that no carp ever got hold of an egg of a black bass unless Mr. Bass had first been taken off from that spawning bed. I do not believe there is such a thing as a carp ever having devoured a single egg from a black bass bed where the black bass was on the bed. Of course if the beds are deserted that is different, but as long as the bass is alive and guarding the bed, no carp ever got a single egg.

Other opinions were expressed, all with the same tenor; but it must be remembered that these are in most cases only opinions. They are expressed by practical fishermen, however, men who have had more experience with the black bass and with the carp than almost any one else in this country, and for this reason their opinions must be given weight.[b]

In the Transactions of the Thirty-second Annual Meeting of the same society (1903, p. 54) a statement similar to the above is made by Mr. J. L. Leary. It is in part as follows:

As to his [the carp's] destroying the eggs or young fish, it is not a fact. My experience is that I could not raise the crappy in clear water, and I adopted the plan of putting so many carp in crappy ponds, and I raised some crappy and no carp, showing that the young carp are all destroyed by the crappy. The smallest sunfish can chase him away, for the carp is a big coward; the carp is a rapid grower and a good fish.

While we are discussing the case of the carp it may be well to give a little more fully the ideas of two members of the American Fisheries Society (Transactions of the Thirtieth Annual Meeting, 1901) as to the probable increase of these fish, as has been suggested above, on account of having young carp for food. Mr. Dickerson, of Detroit,

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[a] This fishery is not prosecuted during the spawning season of the bass; the statement is meant to refer to white-fish spawn.

[b] This question should be tested by introducing a few carp into a bass breeding pond.

speaks of the complaints of the fishermen that carp are destroying the bass fishing on the St. Clair Flats, and then adds (p. 118):

But notwithstanding their claims the bass fishing on St. Clair Flats has been better during the last three years than at any time during fifteen years previous, and we have not planted any bass either. I can not account for it in any other way except that the environments of the carp and black bass are absolutely different. Black bass likes a clean, pure, sandy bottom, and the carp lives on a muddy, weedy bottom. I believe that the carp is a good thing in many waters where black bass thrive. I believe that the bass fishing at the flats has increased by reason of the food that young carp make for the bass, though he was not planted there.

Dr. S. P. Bartlett, of Illinois, who has always been a strong partisan for the carp, says (Transactions American Fisheries Society, 1901, p. 120):

When we take into consideration the fact that is so well known of the voracious habits of the black bass, it shows an all-wise provision of nature to supply a very large quantity of coarse fish to feed the other fishes, and I believe as firmly as I am standing here that if the carp had not been introduced in the state of Illinois, the buffalo having become almost extinct in our waters although it was once the great commercial fish that the bass would have been gradually taken out entirely from the list. As it is now, I want to repeat the statement that we have more black bass than ever, and our carp certainly have increased in a greater ratio than ever before.

This statement, so contrary to what is so often maintained of the bass at the Flats, seems the more plausible when we read in the Report of the Michigan Fish Commission for 1885 (p. 11) the statement that the decline of black bass in Lake St. Clair and the Detroit River was mentioned in the early eighties, and was said to be due partly to their being taken in nets, contrary to law, and partly because they were not protected. At this time they certainly could not have been influenced by carp.

Still more evidence along the same line is brought forward by Townsend (1901). After giving figures showing the increase in the catch of carp in the Great Lakes region and the Ohio and Illinois basin, he continues (p. 178):

These figures show an increase in the quantity of carp derived from the above-named waters amounting to nearly nine times the quantity yielded six years ago. During the same period the total fishery products of Lake Erie increased more than 15,000,000 pounds and those of the Illinois River more than 5,000,000 pounds. There are, therefore, no indications that the presence of the carp has produced any injurious effect on the native species associated with it, but, on the contrary, its presence may have a salutary effect, the young of the carp doubtless being food for black bass and other species. It is certain that the black bass has increased in the Illinois River along with the carp, the yield of black bass in 1899 being greater than ever before, amounting to over 70,000 pounds.

Regarding the relation of carp to some of the other fish I have only a few observations of interest. It seems a noteworthy fact, however, that I have found the dog-fish (*Amia calva*) on its nest, and apparently unmolested, right in the midst of a portion of the marsh which

was traversed daily by the carp in their search for food. Moreover, in the shore zone of the bay where the black bass were studied I found nests of an unidentified species of sun-fish or bluegill, and this was in the regular beat of the carp. The owners of these nests always left them upon my approach before I could get a good view of them, and immediately after their departure a number of small fish which had been swimming about in the neighborhood pounced in and began devouring the eggs. I succeeded in securing a few of these while they were committing their depredations. Those I captured were a small perch (*Perca flavescens*), a related form sometimes known as log-perch or hog-perch (*Percina caprodes*), and a small minnow (*Notropis whipplei* [a]). All had their mouths and gullets crammed with eggs from the temporarily deserted nest. Here we have a suggestion as to one of the important factors that may tend to reduce the number of bass. At the St. Clair Flats, owing to the cold water brought down from Lake Huron, the bass usually spawn considerably later than they do in the interior waters of the state, which become warm more quickly. This is so late, in fact, that the close season prescribed by the law does not protect them at the time they are spawning, and as a consequence great numbers of them are taken by the bass fishermen directly off their nests. In addition, many are also speared, contrary to law, by certain lawless residents of the region. The poacher approaches as close as possible in a duck boat to the bass as it guards its nest, and when within long range throws his long-handled grain. Undoubtedly more bass are hit in this way than are actually secured, for I have seen numbers of them dead along the shore which showed the marks of the spear upon them. What the consequence is as soon as the parent fish is removed it is easy to see. Good food does not lie around unprotected long when there are hungry fish in the vicinity, and it is very probable that if a carp happened along at this time he would not hesitate to avail himself of the opportunity, for a familiar proverb might well be perverted to apply—all is food that comes to the carp's mouth.

In summing up with regard to the damage done by the carp to the spawn of other fish, especially the black bass, we find that there is little in the nature of direct observation, but what there is seems to point to the conclusion that there is little danger to the eggs of these other species so long as they are being guarded by the parent fish. That the carp does eat spawn when occasion presents is not denied even by Doctor Bartlett, the carp's greatest friend. He says, in the Transactions of the Thirtieth Annual Meeting of the American Fisheries Society, 1901 (p. 120):

In order that I might know positively what amount of injury had been done by the introduction of the carp into the waters of the Illinois, I took occasion when

[a] This minnow was kindly identified by Mr. T. L. Hankinson.

carp were first brought upon the market and the hue and cry raised as to their destructive qualities, to open and to be present while hundreds of carps were opened, to see if I could find in their stomachs anything that would indicate that they took the fry of other fish or spawn of other fish. I can not say that I have never found the spawn of other fish in their stomachs, but when I have found such spawn it has been of such a nature as led me to believe that it was such spawn as floated on the surface of the water, and that the carp took them in, in that sucking motion that he has, going around on the surface of the water.

From data given by Doctor Smith (1902) it appears that the blame for the destruction of shad eggs has been wrongfully placed upon the carp. He says that observations in the Potomac River show that the carp do not molest the shad eggs, as they do not go upon the spawning grounds. The greatest amount of shad spawn is consumed by cat-fish and eels. This was shown by having a large shad seine hauled over grounds where the shad apparently had just spawned. Many shad and alewives were caught, but mostly cat-fish (about 5,000 *Ameiurus albidus*) 6 to 18 inches long, and every one of these, so far as observed, was gorged with shad eggs.

With regard to the charge that carp devour the young of other fish, any damage that it may do in this way is certainly so slight that it need hardly be considered. It can not be said that carp never do capture smaller fish, for two or three cases have been reported—one where a carp ate some three minnows that were confined with it in a small aquarium (Gurney, 1860)[a], while in the other cases fish were said to have been found in the stomach. The carp is obviously unadapted by structure for capturing other fish for food. Its mouth is comparatively small and adapted to "sucking," while, furthermore, there are no teeth which could be used in holding living prey. Its only teeth are several rounded, knob-like structures situated well back in the "throat," and known as pharyngeal teeth, and are of service only for crushing and grinding.

As to the third and fourth points, that carp prevent other fish from nesting and that they produce unfavorable conditions which drive other fish away, I know of no proof on either side further than what has been brought out in the foregoing discussion.

I have chosen to consider separately the relation of carp to the white-fish, because the conditions in this instance are rather different and distinct from those in the case of any of the other fishes considered. Then, too, the white-fish fishery is one of the most important in the Great Lakes, and if it were found that the carp interfered seriously with the spawning of the white-fish it would be a very strong point indeed against him.

The white-fish of Lake Erie make an annual migration from the

[a] "A specimen of the common carp, between 5 and 6 inches in length, was lately observed to devour three small minnows, each of about an inch and a half in length, which were confined in the same aquarium with him. One of these the carp seized immediately the minnow was placed in the aquarium and swallowed it whole, head foremost." (Gurney, loc. cit.)

deeper eastern portion of the lake to the shallow reefs at the western end, especially around the islands there, in order to deposit their spawn. The time of this migration varies somewhat with the temperature, but at an average the spawning usually begins in early November and is at its height during the middle or latter half of that month. The eggs are scattered loosely over the rocky bottom.

During my visit to North Bass Island in the summer of 1901, I heard much complaint by the local fishermen, who maintained that in the fall carp did great damage on the spawning grounds of the white-fish. Their statements may be summarized as follows: Carp are abundant about the Bass Islands when the white-fish are spawning; carp eat the spawn of other fish, especially white-fish; white-fish spawn has been taken from a carp's stomach; when carp are numerous on a reef, the white-fish are not there, being driven away by the carp. Carp are not caught here for commercial purposes to any great extent, and the prejudice against them was very strong. At such places as Port Clinton on the mainland, on the other hand, where carp are shipped in enormous quantities, and which is also one of the principal ports for the white-fish fishermen, I found the belief that carp were detrimental to the white-fish either entirely absent, or at any rate not nearly so strong.

In November, 1901, I proceeded to Lake Erie in order to make what investigations I could in the matter. At the time of my arrival, shortly before the middle of the month, white-fish were beginning to be caught in considerable numbers, though very few of the fish were ripe. A week or so later the numbers caught increased greatly, and the spawning seemed to be at its height. The season was an unusually stormy one, with strong northwest winds nearly every day, and one northeaster of several days' duration. The temperature was low during nearly the whole time and there were frequent snow flurries. The fishermen said that probably, owing to the rough weather, the fish did not go upon the reefs to spawn in such large numbers as was usually the case, so that the gill nets, set on the reefs, got comparatively few fish, while many more were caught in the pound nets in deeper water. I spent several days both at Port Clinton and at the islands; at the former place both pound-net and gill-net fish were brought in; the fish landed at the islands were all taken in gill nets.

Very few carp were brought in at either place, and none of them was large, averaging probably less than two pounds. On one day when I visited the pound nets with the fishermen, only two carp were taken. The stomachs of most of those examined at Port Clinton were empty, or nearly so, and in only two cases was any white-fish spawn found. At the time the preliminary statement of this work was published in 1903 (Report of the United States Commissioner of Fish and Fisheries, for 1902, p. 130) only a general and rather superficial exam-

ination of these stomachs had been made, and it was stated that no white-fish spawn had been found. When a more careful examination was made later, one white-fish egg was found among the contents of each of two stomachs. (See Nos. 23 and 24, p. 572.) The rest of the material was mostly remains of insect larvæ, entomostraca, shell fragments, and algæ.

November 27 was spent at North Bass Island and several dozen carp were examined. These fish, all small ones, 30 to 40 cm. (12 to 16 inches) long, were brought in directly from the gill nets, set in from 10 to 25 feet of water, and for the most part on the reefs. Most of the fish had some food in the alimentary canal, and in some cases the stomach was well filled, showing that they had been feeding very recently. Reference to stomachs No. 29 to No. 32 will show that the food was of the same general character as had been found at Port Clinton. Here, again, one stomach contained a single white-fish egg (No. 31).

The facts obtained lead me to quite a different conclusion from the assumptions made by the fishermen. That carp do occur on the spawning grounds of the white-fish is true, and, furthermore, they seem to be moving about and feeding in spite of the lateness of the season and the low temperature of the water. These are mostly small fish, however, and the number of them on the reefs appears to be comparatively small as well. The eggs of the white-fish, not being adhesive to any great degree, probably become widely scattered, and unless the carp were present in large numbers the relative number of eggs destroyed would be small; and that such is the case seems to be proved by the examinations of stomach contents made. That carp capture the young white-fish is even more to be doubted, and certainly no instance has been reported where such is known to have been the case. My conclusion is, then, that while the carp may eat some white-fish spawn, the amount so consumed is so small as to be practically insignificant, especially in comparison with the host of other forms which probably prey upon the eggs now as they have always done in the past. I suspect that by no means the least enemy to these eggs is the common mud puppy (*Necturus maculosus*—called "lizard" by the fishermen) which is often taken in numbers in the pound nets. And, furthermore, the danger to the white-fish spawn has been largely overcome in recent years by the operations of the Bureau of Fisheries, in hatching the eggs in jars and turning loose the young fish in the spring. It has generally been conceded to be due to this, and certainly in spite of the increase of carp, that the white-fish have been on the increase in Lake Erie in the last few years. The catch in 1901 was an especially good one, and was said by the fishermen to exceed any for many years previous.

FOOD VALUE AND USES OF THE CARP.

At the time of the introduction of the carp to this country a greatly exaggerated idea became prevalent as to its value as a food fish, or, at least, as to its qualities as a food fish. This will be noted by a glance at the statements which were sent to the Bureau of Fisheries by those who had received the fish, and which were compiled and published by Smiley (1884, 1886, 1886*a*, etc.) a few years after the fish first began to be distributed. Some of these enthusiasts even went so far as to say that the flesh of carp was of a better quality than that of the trout, white-fish, salmon, and many other of our finer fishes. How such a notion should have become so generally distributed it is difficult to see, for at no time were such claims made for the carp by those who were most interested in its introduction, although it is true that probably most Americans will hardly agree with Mr. Hessel (1881, p. 897) when he asserts that it "is one of the most excellent fresh-water fishes." Mr. Hessel, however, was a German, and in Germany the flesh of the carp is much esteemed. What early habitude may do in determining likes and dislikes as regards food is illustrated by the fact that Germans who live near the Great Lakes, where they could easily get what we should consider better fish, often eat carp from preference, while the American fishermen rarely, if ever, use the carp themselves. As will be mentioned later, the reason for this is perhaps a matter of cooking.

At the present time the popular prejudice is in most parts of the country generally against the carp as a food fish. It is even stated by many that it is utterly worthless. A common complaint made against it is its muddy flavor, and that this often exists is admitted even by those who like the fish best. This flavor has, in fact, always been recognized by carp culturists in Europe, and special precautions are taken to avoid it. It is said to be present in those fish which have lived in very muddy places, especially where the water is stagnant and the temperature rather high. If the carp are removed from such places and kept for a short time in fresh running water, the muddy flavor is claimed to be removed entirely.[a]

In the chapter dealing with the carp in Europe, it has been shown how extensively this fish is used for food there, especially in Germany and France. It is the custom in many places there to keep the fish alive in tanks at the market, thus selling them to the customers not only in a fresh but actually in a living condition.

Many methods have been given for cooking carp—undoubtedly any

[a] Day (1880-1884, p. 162) says: "To improve their flavour Mr. Tull (Phil. Trans. Roy. Soc., 1754, p. 870) castrated these fish and found that subsequently they grew more rapidly, fattened more readily, and were of a superior flavour." Similar experiments have frequently been mentioned, especially in the older works, but there seems to be no record of the attempt having been made recently. In this connection see Weddige (1882).

German knows what are best; but I do not feel competent to judge of them. In general, it would seem that the flesh is best boiled and baked and prepared with some sort of dressing. Dr. S. P. Bartlett (1903, p. 49) gives the following suggestions:[a]

I feel sure that most of the prejudice to the carp as a table fish is from the fact that they are too often taken from the warm water, fried and broiled without preparation. Their rapid growth and the warm water they are taken from, has a tendency to make them soft. I have found the best mode of preparing them as follows: Kill as soon as caught, by bleeding, taking out all of the blood. Skin, soak in salt water for several hours, then parboil and bake, basting frequently. They are frequently served here as a boiled fish, covered with proper dressing. It takes but a slight stretch of the imagination to place [them] on bill of fare as anything from bluefish to buffalo. To-day I had bluefish served with my soup at one of the principal hotels and it would have passed as such with the average man, tell-tale bones, however, said carp.

Carp is probably more often served under the name of some other fish than is generally suspected. Mr. John W. Titcomb gives an instance where it was served at his instigation which shows that this fish when well prepared compares so favorably to many others that few suspect the difference. At the dinner in question there were 224 people present. Mr. Titcomb's account of it is here given (Titcomb, 1902, p. 36):

That the carp is unfit for food, as claimed by many sportsmen, may be contradicted by the statement that at the dinner of the Vermont Fish and Game League held at Burlington, Vt., in January, 1902, at which were entertained the members of the North American Fish and Game Protective Association and representatives of the fishery departments of three Provinces in Canada, the carp was served under the title of "baked red snapper," and was a very palatable dish. The deception was not planned by the hotel managers, but at the request of the president of the league in order that the carp might be fairly tested as to its edible qualities. While a great many of those who ate the fish knew that it was not the genuine red snapper, it is probable that not one of the guests had any idea that he was eating the despised carp.

It is probable that many hotels and restaurants would find it profitable to have carp regularly on their bills of fare, especially such as have considerable German patronage. The report of the Commissioners of Inland Fisheries and Game (of Massachusetts) for 1893 (published in 1894) quotes the statement that at that time at least one restaurant in Cleveland regularly had carp on its bill of fare; and a

[a] Doctor Bartlett also gives a recipe for "carp omelet" or "carp jelly," said to be of Swedish origin. It was given to him by Doctor Weiss, of Ottawa, Ill., who declares that the perfected product is equal to the imported fish jelly that brings $1 per pound. The recipe is as follows:

Take a 6 or 8 pound carp; scale and skin. Leave head and skin [fins?]. Cut into small pieces and place in boiling water just sufficient to cover, and add salt, coarsely ground pepper, allspice, and a bay leaf or two. Boil about twenty minutes or until perfectly soft. Remove from the fire, remove pieces of fish from the water, but preserve the water. Break the pieces so as to be able to remove all of the bones thoroughly. Skin fins and head pieces. Strain liquid through a colander and if necessary add a cupful of gelatin, previously dissolved, to this liquid. At the same time add such other pieces as may be desired. Add the original pieces of fish to the liquid or gelatinized liquid. Stir and place on ice until solidified.

recently published menu[a] of the café luncheon of the Waldorf-Astoria, New York, for April 16, 1902, contains the item, "Carp, Rhine Wine sauce" at 65 and 40 cents.

It is not maintained, however, that the attempt should be made to put carp on an equal footing with our admittedly finer fishes. It is merely desired to show that if the prejudice at present prevailing against it as a food fish could be removed it would be much more extensively used than at present. Even now hundreds of tons of carp are being consumed yearly in the larger cities of this country, though the demand can still not be considered equal to the possible supply. The amount of these fish now used will be considered under the subject of the carp fisheries (p. 617). The sale is at present mostly limited to the poorer classes in the cities, and especially to the Jewish people. For this trade it is necessary that the fish be shipped "in the round," and those that have previously been cleaned will not be accepted.

Several methods of specially preparing carp have been tried to some extent in this country, but none of them has as yet been attempted on a large scale. I was told that canning carp had been tried in Cleveland, but was unable to get any definite information on the subject. If the dogfish of our coasts, a species of shark, can be put up successfully in this form, as is now maintained, it seems that as much might be expected of the carp. The greatest difficulty would be, in both cases, in overcoming popular prejudice and in establishing a market for the product.

A few firms along Lake Erie have been smoking a considerable quantity of carp, which has, however, never had a wide market, but has been disposed of locally. For this purpose the larger fish are used, weighing usually 12 to 15 pounds. With a sharp knife the skin and scales are cut off in broad strips (about three to a side), the cuts not going so deep, however, but that the imprints of the scales still show on the flesh. The head, viscera, and fins are all cut away, and the fish is then cut up into transverse sections or "steaks" some 2 or 3 inches in thickness. This last process is readily accomplished by means of a sharp knife fixed in a long-handled lever, as is shown in figure 4, plate II (the operator to the left). Two skilled operators can prepare a large number of fish in this manner in a comparatively short time. The steaks are strung on long iron rods and are smoked in the ordinary way. I was told that this product was sold as smoked carp and retailed at about 15 cents per pound. The claim was made that "except for the bones it could not be told from smoked sturgeon," and that I myself tried I found to be very palatable. At a retail market in Sandusky I actually found smoked carp on sale at 18 cents per pound under the name of smoked sturgeon. The larger fish are not readily

[a] This menu has been reproduced in Transactions American Fisheries Society, Thirty-second Annual Meeting, 1903, p. 123, and in the Report of the [Illinois] State Board of Fish Commissioners, 1900-1902.

sold in the round, those of 3 to 5 pounds' weight being considered best for cooking, and it seems that smoking should be an important way to utilize the less desirable size. I am unable to give even approximate figures of the amount or value of this particular product at this time, but it seems to be an industry which is capable of being developed upon a paying basis to a much greater extent than at present.

Wholesale dealers who have tried the experiment of salting carp down, as is done with the herring, and thus holding them over to a season when they would demand a higher price, inform me that the experiment was not a success. This is probably due largely to the fact that the Jewish people are by far the largest consumers of carp in this country, and they want the fish as fresh as possible. It was also the opinion that the salting had a deteriorating effect upon the quality of the flesh. It is a common practice in most of the large fish houses, however, to freeze large quantities of carp when the supply is greatly in excess of the demand at the time and to hold them over in this condition until there is a market for them.

The scarcity of sturgeon and the high price brought by caviar naturally suggested to many the possibility of using the roe of the carp for their purpose. While the eggs are small, a single large female often contains a large quantity of them (see p. 574), and during the breeding season carp roe could be obtained in abundance. But those on the Great Lakes who have attempted to manufacture caviar from the roe of the carp have all reported a failure, complaining that in the process the eggs turn pink or red. Inquiries have been made as to whether this could be avoided. This change of color is probably always characteristic of caviar made from carp eggs, as is evidenced by the following quotation from Walton (1901 ed., p. 116):

> But it is not to be doubted but that in Italy they make great profit of the spawn of Carps, by selling it to the Jews, who make it into red caviare, the Jews not being by their law admitted to eat of caviare made of the Sturgeon, that being a fish that wants scales, and, as may appear in Leviticus xi, by them reputed to be unclean.

It is possible that similar caviar made in this country would find a ready sale in the large cities, such as New York and Boston, where there are large settlements of Jews.

It is said that in some parts of Europe "the palate, commonly termed the 'tongue,' is considered a great delicacy."

In common with numerous other fishes certain parts of the carp were formerly considered to be of great medicinal value. Thus Walton, on the page quoted above, says that "physicians make the galls and stones in the heads of Carps to be very medicinable."

Besides being of value as an article of food there are a number of other ways in which carp may prove to be most useful. Perhaps the most important of these is in helping to keep in check the increase of noxious insects which pass their larval stages in the water, and especially

that ever-present cosmopolitan pest, the mosquito. Howard (1901, p. 161) emphasizes the importance of fish in this respect and gives an instance where carp are said to have been very effective, though he himself doubts whether carp could have been the fish that destroyed the larvæ. He says:

> It was stated a number of years ago in *Insect Life*, that mosquitoes were at one time very abundant on the Riviera in South Europe, and that one of the English residents found that they bred abundantly in the water tanks, and introduced carp into the tanks for the purpose of destroying the larvæ. It is said that this was done with success, but the well-known food-habits of the carp seem to indicate that there is something wrong with the story. If top-minnows or sticklebacks had been introduced, however, the story would have been perfectly credible, and it points to the practical use of fish under many conditions. Some years ago Mr. C. H. Russell of Bridgeport, Conn., described a case in which a very high tide broke away a dike and flooded the salt meadows of Stratford, a small town on the north side of Long Island Sound. The receding tide left two small lakes nearly side by side and of the same size. In one lake the tide left a dozen or so small fish, while the other was fishless. An examination by Mr. Russell in the summer of 1891, showed that while the fishless lake contained tens of thousands of mosquito larvæ, that containing the fish had no larvæ.[a]

From the results of the stomach examinations recorded in the earlier pages of this report it does not seem that Howard's conclusion that carp did not destroy the larvæ in the tanks in question is warranted. While it is true that no mosquito larvæ were found among the intestine contents examined in connection with the present investigation, this may have been due to their small size; the fact that in some cases the food of the fish seems to have consisted almost entirely of insect larvæ makes it probable that those of the mosquito would be taken as well. Since it is reasonable to suppose that there was little or no other food in the tanks mentioned in the above quotation, it is all the more probable that the carp would there have eaten the mosquito larvæ, and I see no reason to doubt the original statement. It may well be that among our native fish there are some species, such as the stickleback and top minnow, which are better adapted to this purpose than the carp, but the latter is not for this reason a negligible factor. Undoubtedly many ponds that annually breed millions of mosquitoes need only to have plenty of fish introduced in order to abate the nuisance. If carp will do this as well as other fishes, it will serve a double purpose, as it can also be used for food.

Another, and perhaps even greater, benefit to be derived from the presence of carp has recently been suggested in a bulletin by Doctor

[a] In February and March, 1904, I had similar opportunity to observe the efficacy of fish in keeping the waters where they are present free from mosquito larvæ. About the hacienda at Chichen-Itza, Yucatan, there are a number of large tanks which are kept constantly filled with water for the stock and for other purposes. In some of these tanks mosquito larvæ were very abundant; but in the others, into which a few small native fish, locally known as "mojarras" (*Heros urophthalmus*), had been introduced, none were to be found. The same was true of two natural pools in the vicinity where these fish lived, while, on the other hand, large numbers of larvæ could be found in small hollows in the rock and other places where the rain water had been standing for a few days.

Stiles (1902), of the United States Bureau of Animal Industry. It was learned by Doctor Hutchinson, an inspector of the Bureau in Oregon, that sheep from the lowlands along the Columbia and Willamette rivers, where carp are numerous, are much freer of the fluke disease than those from other sections of the country, and it is suggested that the parasites (*Fasciola hepatica*) which produce the disease may be destroyed by the carp while in a cystic state (cercariæ) and attached to the leaves of grass or while they are in their intermediate host, the common fresh-water snail *Limnæa*. In a letter to the Bureau, dated December 2, 1901, Doctor Hutchinson writes:

Prof. C. V. Piper, of the Washington Agricultural College, in conversation with me, mentioned the theory which I find is, as he said, extant in the minds of many farmers along this river, namely, that "leeches" [liver flukes], which were formerly numerous in the livers of cattle and sheep, have to a considerable extent disappeared since the introduction of carp into the waters of this river.

While, of course, the farmers' idea is that the carp now consume the leech which, according to their view, the cattle formerly swallowed with the water while drinking, it is possible that there may be a practical connection between certain peculiar habits of this fish and the noticeable freedom from fascioliasis among the cattle and sheep ranged on the bottoms adjoining streams in which these fish are found, compared with animals coming from other sections where carp are unknown. About 75 per cent of the cattle and sheep coming from the western slope of the Cascades, exclusive of this Columbia River bottom, are infested with *Fasciola hepatica;* but from this particular portion only about 5 per cent are so infested.

And in another letter of later date (January 4, 1902) he adds:

I am able to say that fascioliasis is much less common in animals from the lower Columbia and Willamette slough lands than from any other swampy districts of Oregon or Washington.

The carp have the more chance to destroy these parasites since the bottom lands are subject to annual overflow, and at such times the fish spread over the meadows and root out and eat much of the grass. Although I do not know that any species of *Limnæa* has been actually identified in the alimentary tracts of carp, there can be no doubt, as Doctor Evermann states in a letter quoted in the above bulletin, that carp do eat them when they are at hand. Doctor Stiles appears to have justification for his final statement that "the action of the carp in this case appears to be very strongly supported by the facts stated, and it seems that the introduction of carp into fluke districts generally would result in a great decrease of liver-fluke disease."

The Bureau of Fisheries, as well as some of the state hatcheries, have found that young carp make very good food for black bass, and according to the reports of the Bureau at least 1,000,000 of these small fish must have been used in this way in the years from 1894 to 1896. They have also been used to put into trout ponds to clean out the foreign matter, to destroy the algæ, etc. (Report United States Fish Commission for 1900 (1901), p. 57). It is possible that small carp would

make excellent bait for bass, and perhaps other fish, but I do not know that they have been tried.

On account of its hardiness and the readiness with which it will accommodate itself to small quarters the carp makes an excellent aquarium fish for exhibition purposes. At the large market in Boston there are several large carp in a glass tank so small that the fish now have barely room to turn around. It is said that these same fish have been there for a number of years.

When carp began to be common in Lake Erie it was suggested by many that perhaps the air bladders, or "sounds," as they are called, might be used for the manufacture of isinglass, which is extensively used in clarifying wines and in similar ways. At present about the only fresh-water fish whose sound is used for this purpose is the sturgeon, and the sturgeon fishery is comparatively so small that the sale of the sounds amounts to very little commercially. Those who had tried to use carp sounds for this purpose had not been successful. Nevertheless, at my suggestion, Mr. John Tufts, of the Cape Ann Isinglass Company, made further tests on some sounds which were procured for me by Mr. Cleaver, of the firm of R. Bell & Co., Port Clinton, Ohio. Mr. Tufts writes me as follows:

> In regard to the carp sounds which you sent me, will say that I have tested them and find that [they] will not answer our purpose, inasmuch as they do not seem to contain any glue.

Finally, where carp are taken in greater numbers than can be used for food, or where the attempt is being made to rid waters of them, they can always be used for the manufacture of valuable fertilizer. The importance of fish for this purpose and the extent of the industry in some parts of the country, have recently been well described by Stevenson (1903). Fish refuse is regularly sent from many fish houses in the region to the fertilizer factory at Sandusky, but under present conditions carp contribute very little to this, being shipped almost entirely in the round.

The possible value of the carp as a game fish will be discussed in a later section (p. 619).[a]

THE CARP FISHERIES.

Within the past decade the carp fishery has increased to such an extent in the general regions of Lake Erie and the Illinois River that it now forms a recognized and independent industry. Although it

[a] There is one purpose for which the carp would afford valuable opportunity which has not been mentioned—that is, as material for scientific study of variation and heredity among fishes. Experiments in this line have been actively prosecuted in recent years, especially with plants and mammals; but so far as I am aware nothing has been done as yet with a fish. That the carp would be an excellent subject for such experiments is evident from its great variability, its adaptation to domestication and the consequent ease with which it can be reared, its hardiness and rapid growth; and, finally, its great fertility, affording abundant material for quantitative results. Probably the only rival of the carp as a fish for this purpose would be the gold-fish, which might be preferable on account of its smaller size.

is carried on to some extent throughout the entire year, and some persons devote their whole time to it, the bulk of the fishing, in the Lake Erie region, comes in spring and summer, when the number of men engaged is greatly augmented. Many of these persons are professional fishermen who at other seasons are engaged in catching other kinds of fish; but many also are farmers, usually living in the vicinity of the fishing grounds, who supplement the income of their farms in this way. For this reason it is very difficult to estimate the number of men engaged in carp fishing, either for a part or for the whole of their time.

By far the greater number of carp marketed are taken in seines, and the methods differ only in details from those employed in seining generally. For this reason I shall give but a short description of the methods employed, and shall confine my remarks to the fisheries along Lake Erie and the adjacent waters. Apparently about the same methods are employed by the Illinois fishermen. (See illustrations in Illinois fish commissioner's report, 1900–1902.)

Some of the fishermen, especially those who fish along the shores of Lake Erie, make their headquarters in the cities where the wholesale houses are situated, making trips of two or three days, or even a week or more duration along the shores, and running back when they have a load of fish. These trips are made usually in open, flat-bottomed boats, of the style known on the lakes as "seine boats" and "pound boats." They are rigged as single or double "cats," but with the sail extending beyond the gaff to form a sort of permanent topsail. Others, and especially the farmers who fish for only a portion of the year, usually have a permanent camp established near some of the marshes. The fish when caught at these places are transferred at once to live-cars if to be kept but a short time, or to artificial ponds if they are to be kept longer, and are later sent to the wholesale houses either in wagons or by boat.

SEINING.

The seines used in this fishing are commonly 40 to 50 rods in length, about 18 feet deep in the middle and 10 feet deep at the ends. The middle portion or bag is generally about 5 rods long and has a 3-inch mesh, while the wings have a 4-inch mesh. Longer seines—to a length of 80 rods—are sometimes used, but are usually found to be too inconvenient. The cork-line is well supplied with floats to keep it up, but there are usually no weights on the lead-line. The lead-line is made shorter than the cork-line, however, so that it hauls somewhat ahead of the latter and hugs the bottom. The seine boats commonly used are open, flat-bottomed, centerboard boats about 20 to 30 feet long, square at the stern, and fitted with a single mast (fig. 3, pl. II). The seine is loaded into the stern of the boat in such a way that it can be paid off easily, and is taken to a ground where the fishermen have

reason to think there are carp. There are usually certain definite beaches where the hauls are made, places that are known to be comparatively free of vegetation and snags. As the summer advances it becomes more necessary to make the hauls on regular grounds, which are thus kept comparatively free of weeds. Where the seine has not been more or less regularly hauled the weeds become so abundant that it is impossible to make a good seine haul over them, for the lead-line trips and can not be made to hug the bottom. The various hauling grounds are patrolled with considerable regularity, and as soon as the fish come on in any numbers the fishermen are usually aware of it.

For a seine of the size mentioned a crew usually consists of not less than four men, though two crews sometimes help each other haul, thus reducing the labor. Nominally the waters are free for any one to fish in them, but as a matter of fact certain crews come to have a feeling of ownership for the hauling grounds they have established, and in this way they assume rights which are generally respected among themselves by an unwritten law.

Arrived at the hauling grounds, the fishermen proceed with caution, making as little noise as possible, so as not to frighten the fish. A long brail rope is bent to each end of the seine. The free end of one of these is left on shore, where a part of the crew remain as well, and the others row the seine boat out in a big sweep around the hauling ground. First the brail rope is paid out and then the seine itself, and finally the other brail rope is carried to the shore at a considerable distance from the point of starting. One person in a small duck boat usually follows along the seine to see that it sets right, and that it has not caught on any snags. The brail ropes are now passed around the drums of wooden reels or windlasses, and wound slowly in, one man keeping the line taut while one or two others wind in. In the meantime the fisherman in the duck boat follows along the net as it is gradually brought in, watching to see that it does not trip and freeing it if it catches.

When the brails have been brought close into the shallow water the two ends of the seine are carried along shore to some median point, and the net is now pulled in directly, hand over hand. In order to keep the lead-line down to the bottom a "jack" or "roller" is pushed down into the mud, so that the line runs under a sort of wooden spool. In this way the seine is gradually hauled in until all the fish are bunched in a small portion of the bag (figs. 1 and 2, pl. II), from which, with short-handled dip nets, they are either transferred directly to floating wooden crates or live-cars, or are placed in a boat and later transferred to the cars (fig. 3, pl. II.) The seine is then again loaded upon the seine boat, and if another haul is not to be made soon is taken ashore and spread out on a reel to dry.

Under certain conditions special methods of seining are regularly

employed. For example, some of the marshes connected with small tributaries of the Sandusky River open into the main channel by outlets so definite that any fish which happen to be in the marshes can be shut off from the river simply by setting a seine across these outlets. As has already been explained (p. 558), on account of the varying direction and force of the winds over Lake Erie the water level is almost constantly changing, affecting also the level of the waters of the bays, rivers, and marshes. By experience the fishermen have learned that when the current sets up and the water level is rising, the carp work up the streams and spread out over the marshes. Conversely, with the fall of the water they move out of the marshes again into the deeper waters. So careful watch is kept of the currents, and shortly after the water has reached its highest, and is beginning to go down again, a seine is stretched across the outlet from the marsh, as described above. A row of stakes is placed in a semicircular line on the downstream side of the seine to prevent its being carried away by the force of the outgoing current, and the cork-line is made fast to each of these stakes, so that the net will not be carried away if the current should change and set upstream again. As the water recedes the carp crowd on the upstream side of the net in large numbers, and when the fishermen decide that enough have come down to justify it, the haul is made. If the current is still running out, a second seine is often set immediately in the place of the first. The fishermen can get some estimate of the number of carp that have gathered above the seine by the number that are seen splashing, or by running a paddle slowly through the water, when, if there are many fish present, they can be felt to bump against the paddle. To make the haul, a brail rope is carried across upstream from one side to the other, and the net is wound in to one shore in the usual way.

An outfit for seine fishing, including seine boat, seine, lines, and other accessories, represents an outlay of about $150 to $200. In other words, a capital of $40 to $50 each is required where the crew consists of four men. Some crews, consisting, perhaps, of only two or three men, who work on a smaller scale, are probably able to outfit for a smaller sum. In some cases the outfit is furnished by a wholesale dealer or fishing company, and the fishermen work on a salary or on a percentage of the value of the catch.

The time ordinarily required to make a seine haul and dispose of the fish is from one to two hours, though it may vary with conditions, and the haul is not considered to have paid unless at least half a ton of fish is taken. As a rule, the fishermen will not make a haul unless they think there is a chance of getting a greater amount of carp than that. The number of fish which may be taken at one time depends in large part upon the season, and the size of single hauls sometimes made during the spring months is almost incredible. Upon what appeared to be reliable information there were reported to me a num-

ber of hauls in which 10 tons of carp were taken at one time. It would probably be fair to assume that these fish taken in the spring averaged in the neighborhood of 8 pounds each, which would mean that each haul contained some 2,500 fish. The largest single haul of which I heard at Lake Erie was said to have contained 14 tons of fish. A recent apparently well-authenticated report from Lake St. Clair, however, exceeds this by more than as much again. Net fishing in Lake St. Clair has been prohibited by the state of Michigan until within a short time, and in the favorable marshes of the St. Clair delta and about the mouth of the Clinton River the carp had increased to an amazing extent, resulting in some phenomenal hauls now that seining for these fish is permitted. The American Fish Culturist for July, 1904 (vol. 1, no. 7, pp. 18–19), quotes from the Detroit News an account of probably the largest haul on record, and adds further confirmation of the report from Mr. Seymour Bower, superintendent of the Michigan state hatcheries. The article seems of sufficient interest to quote in full:

"That despised fish known as the German carp is having a growing commercial value, and with the possibilities of carp fishing in mind, Carl Schweikart formed two companies, the St. Clair and Erie Carp Company and the Detroit Carp Company. The field of operations is at the mouth of the Clinton River, where the water is clear and the fish are supposed to be at their best. The former company has had phenomenal success in carp catching, having taken in one haul last week 7,200, which they suppose will average about 8 pounds. The catch was made about 8 o'clock in the morning, and several men were kept busy all day getting the carp out of the nets and into the ponds in which the carp are kept until sold. Eastern buyers are figuring for the purchase of their entire catch, but Mr. Schweikart is inclined to wait for better prices. The quotation in New York is now 3 cents a pound.

"What do they do with the carp? Well, they are considered a delicacy by hundreds of patrons of the best hotels and cafés in the East, but the name 'Great Lakes salmon' is preferred."

Referring to the above, Mr. Seymour Bower, superintendent of the Michigan State hatcheries, says:

"The big haul was made in Lake St. Clair, near the mouth of Clinton River. Net fishing of all kinds was prohibited in this lake until the last legislature passed an act allowing the seining of carp. This lake, as you may know, is famous for its small-mouth bass fishing, and it is claimed that the presence of the carp in such overwhelming numbers is bad for the bass; hence the passage of this law."

"Mr. Schweikart is interested in two companies fishing for carp, and I supposed that report of the catch for the month of May, received a few days ago, covered everything in which he was interested, but it was for one company only. The report for the other company was received this morning, and the big haul is there all right. I then called Mr. Schweikart by 'phone and he not only confirms the statement made in the clipping, but says the half was not told, and I know Mr. Schweikart is thoroughly reliable. He states that from the big haul they impounded 7,200 carp by count; and for want of time and facilities for handling were obliged to let fully as many more go, and that the fish taken will average not less than 10 pounds in weight. The two companies in which he is interested impounded 44,900 carp by count in May, or upward of 200 tons.

"Following are the rules under which eleven firms are now fishing there:

"RULE I.

"No person shall catch German carp in any manner except with hook and line, without first notifying in writing the State game warden and the State Board of Fish Commissioners, at their office in the city of Detroit, of the time and place where he intends to fish for carp.

"RULE II.

"No person shall catch or take German carp from said waters except with a seine with a four-inch mesh extension measure as used, and with a hook and line. No person shall catch or take German carp with a seine without first giving a good and sufficient bond conditioned for the faithful observance of these regulations and for the payment of a penalty of fifty dollars ($50) for each and every violation of these rules and regulations.

"RULE III.

"If German carp which are caught are to be kept for future sale, shipment, or delivery, a pond or other suitable inclosure shall be prepared in which said carp shall be placed and kept, and the State game warden and the State Board of Fish Commissioners shall be forthwith notified in writing of the location of such pond or inclosure. Said pond or inclosure shall at all times be open to the inspection of the said game warden, or any of his deputies, and to the inspection of the State Board of Fish Commissioners, or to the inspection of any person appointed by said board for the purpose of inspecting said carp and the manner of fishing therefor.

"RULE IV.

"When any such German carp are killed and sold, shipped, or delivered, the owner or shipper shall make duplicate invoices of the same, one of which shall forthwith be delivered or mailed to the State game warden, or to such person and to such place as he may designate, and the other shall accompany the package of carp so sold, shipped, or delivered. Said invoice shall truly state the time and manner of shipment; by and to whom consigned, sold, or delivered. Every fisherman who shall engage in business of catching German carp shall once a month make a report to the State Board of Fish Commissioners, which report shall contain a true statement of the quantity in pounds of the daily catch of German carp made by him during the month. Said report shall be mailed or delivered as aforesaid on or before the fifth day of each month.

"RULE V.

"Every package of German carp sold, shipped, or delivered shall be plainly marked so as to show what it contains. It shall also show by whom same is sold, shipped, or delivered, and such package shall contain no other kind of fish whatever.

"RULE VI.

"When any other kind of fish than German carp shall be caught or taken in the seine prescribed by law and by these regulations, the same shall be carefully put back in the water and, under no circumstances, kept by the fisherman.

"RULE VII.

"Whenever a special inspector shall be required to watch the taking, killing, or shipping of German carp by any fisherman, the expenses of said inspector, not exceeding three dollars per day, shall be borne by such fisherman.

"The right to amend and alter these regulations at any time is especially reserved by the State Board of Fish Commissioners, and will for each violation of any of the laws of Michigan with reference to the protection of fish, pay to the State Board of Fish Commissioners the sum of $50, then this obligation is to be void, otherwise to remain in full force."

The laws governing the taking of carp in Lake St. Clair are quoted to show what can be done in cases of this kind to allow of the utilization of the carp, to decrease their numbers, if that seems necessary, and still to afford protection to the native fish, especially the game fish, such as the black bass.

OTHER METHODS OF CAPTURE.

The number of carp taken by other means is insignificant as compared with that taken by seining—in fact, it is seldom that any other kind of net is set exclusively for carp. Small numbers are taken more or less regularly in the pound nets set in Lake Erie for saugers and pickerel (wall-eyed pike) and for white-fish, as well as in the traps and fyke nets set in the bays and rivers for other species of fish. A few carp—mostly small ones—are obtained in the gill nets set for white-fish about the Bass Islands in the fall. Occasionally when a number of carp have entered some place where a net can be set across their only way of escape, or where they can be driven into it, a gill net is used. Thus if carp are frightened out of the rushes where they are feeding they will usually make directly for deeper water. If a gill net is set so as to intercept them many will rush into it and become entangled; but they are such vigorous fish that unless the net is an exceptionally strong one they are apt simply to tear it to pieces. I believe trammel nets have been tried in the same way, but not with enough success to warrant their general use.

PACKING AND SHIPMENT.

The method of transportation of the fish to the fish houses has already been mentioned (p. 611). The fishermen may dispose of them immediately after they are caught, or they may keep them for a time pending a rise in the market price. In the latter case the carp are retained in pens or ponds as will be described later. The fish are received at the wholesale houses often in a living condition, although they may have come a distance of several miles packed a foot or two deep in a wagon or boat. They are transferred from the boats to boxes by means of short-handled dip nets, the iron frames of which are usually straight on the side opposite the handle, a construction which facilitates using them to take fish from the bottom of a boat. The boxes are now slid inside the fish house and placed on the scales where the fish are "weighed in," and are then dumped out in a pile on the floor. Usually no record is made of the number of fish, but all measurements are by weight. As soon as possible the fish are packed into plain lumber shipping boxes of uniform size and especially made for this purpose. A box is placed on the scales and chopped ice is shoveled in until it tips a certain weight; a 150-pound weight is then added, and carp are shoveled in until it is balanced. For handling the

fish when they are on the floor ordinary large scoop-shovels are used. Each day the boxes of carp are shipped either by freight or express to the large cities, where they are in demand. From the fact that some of the fish from Lake Erie at times reach New York still in a living condition, it will be seen that there is no need that the fish should be cleaned before shipment, even did not the consumption of the greater portion by Jews demand that they be shipped "in the round."

Some firms, when the supply of carp exceeds the demand at the time, freeze a part of the catch and hold them over in this way, but the frozen fish do not find so ready a sale.

EXTENT OF THE FISHERIES.

The amount and value of the carp output of Lake Erie has been steadily on the increase for the past eight or nine years. The fish first began to be handled by the dealers in about 1890 or 1891, but had no extensive market until about 1895. At a fish house in Port Clinton it was stated that when they first began to be taken they were thrown in with the mullets and sold at 1 cent a pound, and the dealers did not want them at that price. They were then put on the list as German carp, at 3 cents, and at once found a ready sale.

That the fishery had not become established in 1892 is shown by the fact that carp are not mentioned under the "Products of Lake Erie fisheries," in the Report of the United States Fish Commission for that year (p. cl), nor in the paper by Smith in the same report on the fisheries of the Great Lakes.[a] They were being used more or less in other places, however, and Smith (1898, p. 494) estimates the amount of carp taken in the waters of the United States, exclusive of the Great Lakes, in 1894, as 1,448,217 pounds, valued at $37,683. The catch from Illinois was more than four times that from any other state, Iowa coming next. The Lake Erie fisheries had increased enormously by 1899, and Townsend (1901) in reporting for that year says (p. 178):

> The catch of carp in Lake Erie in 1899 amounted to 3,633,679 pounds, valued at $51,456. The report of the Illinois Fishermen's Association shows that the catch of carp in the Illinois River is greater than that of all other species combined, the quantity of carp taken in 1899 amounting to 6,332,990 pounds, valued at $189,980. The yield of carp from the Ohio River and two of its tributaries, the Cumberland and Wabash rivers, during the same year, amounted to 113,387 pounds, worth $6,654.
>
> These figures show an increase in the quantity of carp derived from the above-named waters amounting to nearly nine times the quantity yielded six years ago.

[a] Although the Lake Erie and Illinois carp fisheries had not become established at this time, these fish from eastern waters were finding a ready sale in the New York markets. This is shown by the following statement of Mr. John H. Brakeley (1889a): "I have sold several hundred pounds of carp during the past autumn in the New York market, the commission merchants getting 15 cents a pound for them. I am satisfied that it will pay to feed carp, and shall do considerable of it next season."

In the summer of 1901 I myself visited all the principal fish dealers on Lake Erie, and made as accurate an estimate as possible of the extent of the carp fishery for the calendar year 1900. A number of factors prevent great accuracy in such an inquiry; for example: (*a*) Some dealers keep no record whatever of the carp handled by them; (*b*) others keep record only of their own catch, not recording those bought by them from fishermen; (*c*) in some cases the carp are weighed in and sold with the suckers, and (*d*) it sometimes happens in the spring that carp come in faster than they can be handled, when the surplus is weighed up with the refuse, and sent to the fertilizer factories. In spite of this, however, it is felt that the following statistics give a fair estimate of the total amount of carp shipped from Lake Erie in 1900:

	Pounds.
Detroit, Mich	300,000
Monroe, Mich	14,000
Toledo, Ohio	432,548
Port Clinton, Ohio	2,361,723
Sandusky, Ohio	1,260,817
Total for western end of lake	4,369,088
Huron, Ohio	14,168
Vermilion, Ohio	3,561
Lorain, Ohio	20,773
Cleveland, Ohio	16,000
Ashtabula, Ohio	2,500
Erie, Pa	12,000
Buffalo, N. Y	160,000
Total for eastern end of lake	229,002
Total for lake	4,598,090

The price paid to fishermen for carp varies from about 30 cents per 100 pounds in the spring months to 2½ cents per pound in the winter. Taking 1½ cents per pound as a fair average, the value of the carp catch of 1900 would be $68,971.35. This is an increase of 964,393 pounds over the catch of 1899, and an increase of valuation of over $17,000. As nearly as could be judged at the time, the catch for 1901 promised to be about as much larger than that of 1900. No accurate statistics have been gathered since that time, but the fishermen say that the fishery is still increasing.

The number of pounds of carp taken in Lake Erie in 1899 equaled nearly one-sixteenth of the total catch of fish of all kinds in the lake for that year, while the value was about one twenty-second of the entire fisheries product.

In the Mississippi River and the streams tributary to it, especially in the Illinois River, the carp fisheries are of far greater comparative importance, and for several years carp have constituted over one-half of the total yield of the fisheries of the last-named stream (Townsend,

1902, p. 150). In 1899 the catch for these streams was 11,869,840 pounds, valued at $289,258. In a letter dated October 19, 1903, Dr. S. P. Bartlett states that the value of the output in 1901 from the Illinois River was nearly two-thirds of a million dollars, 17,000,000 pounds being the output;[a] and in a previous letter—

I am safe in saying that of all the fish produced in our inland waters and rivers the carp will bring the fishermen more money than all their other catch.

ANGLING.

The anglers for trout and bass naturally look upon the carp with great contempt. Nevertheless there are those who are ready to champion the foreigner, and some would even rank him as a game fish. In Germany, angling for carp in the open waters has afforded recreation, and has been a not unimportant factor in the food supply of the people; and in England carp have been sought by the angler since their earliest introduction into that country. They are mentioned among the fishes included in the treatise on angling in the "Boke of St. Albans," first published in 1486, and consisting of a number of compilations often attributed to Dame Juliana Barnes (or Berners), though the section on angling was probably not written by her. This account is interesting as being probably the earliest record we have of the carp in the English language; and being brief, may well be quoted here:

The carpe is a deyntous fysshe: but there ben but fewe in Englonde. And therefore I wryte the lasse of hym. He is an euyll fysshe to take. For he is soo stronge enarmyd in the mouthe that there maye noo weke harnays holde hym. And as touchynge his baytes I haue but lytyll knowlege of it. And me were loth to wryte more than I knowe & haue prouyd. But well I wote that the redde worme & the menow ben good baytys for hym at all tymes as I haue herde saye of persones credyble & also found wryten in bokes of credence.[b]

In the later English writings on fishing, the carp is accorded a prominent place, and Izaak Walton (1901 ed.) devotes a chapter to its natural history and the modes of capture. He styles it "the queen of rivers; a stately, a good, and a very subtile fish," and says (p. 17):

And my first direction is, that if you will fish for a Carp, you must put on a very large measure of patience, especially to fish for a River Carp: I have known a very good fisher angle diligently four or six hours in a day, for three or four days together, for a River Carp, and not have a bite.

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[a] It would seem that Doctor Bartlett has put the valuation rather high. Two-thirds of a million dollars for 17,000,000 pounds of fish would mean a value of slightly over 3.8 cents per pound. At the same rate used in estimating the value of the Lake Erie catch above (1½ cents) the Illinois River catch for 1901 would be worth $255,000. If we estimate the Lake Erie catch for 1901 on the basis of the catch of 1900 over that of 1899 (an increase of nearly a third) it would amount to approximately 5,800,000 pounds, with a value of $87,000, making a total of 22,800,000 pounds, worth $342,000 for the two regions. There are no data at hand for estimating the amount of carp caught in other parts of the United States, but it is probably comparatively small in proportion to that for the regions given.

[b] From a reprint of the Wynkyn de Worde edition of 1496 (London, 1810, treatise of "Fysshynge with an angle," signature i j).

He then goes on to tell when one should fish, the kinds of bait that should be used, and ends with an elaborate recipe for its cooking.

Perhaps the best directions for fishing for carp with hook and line are those quoted from Pennell by Goode (1888, p. 414) in his popular treatise on American Fishes.

> Early in the morning, and, occasionally, late in the evening, are the best times for fishing; but, as observed, the catching of Carp with the rod and line is always a difficult and uncertain operation, particularly if the fish are large. The smaller the pond, the better the chance I have always found of catching Carp and Tench, though, of course, they are not so large as in bigger waters. I once caught a bucketful of Carp before breakfast, in a pond by the side of a road between Weybridge and Byfleet, which was not bigger than an ordinary sized ball-room. The biggest of these Carp did not, however, exceed 2 pounds in weight.
>
> The following is the method of Carp fishing in stagnant waters which I have found most successful:
>
> Let the line be entirely of medium sized or fine round gut—clouded, if possible—with a very light quill float, say No. 4, and one good-sized shot, about 6 inches or so from the hook, which should be No. 5 or 6 and baited with a brandling or red worm. Plumb the depth accurately; and arrange the distance between the float and the shot, so that the latter may exactly rest on the bottom, weighing down the point of the float to about "half-cock," and letting the gut below the shot and the bait lie on ground. Fix the rod in the bank and keep perfectly quiet. When a bite is perceived, do not strike until the float begins to move away.
>
> It constantly happens, however, that the Carp will not be taken either by this or any other mode of fishing with which I am acquainted; but if he is to be caught at all it is thus.
>
> The baits are, worms (first), gentles, greaves, grains and various sorts of pastes, of which latter, however, I believe the plain white bread crumb paste is the best, as well as the most easily made. Professor Owen, who had a good deal of Carp fishing experience in Virginia water, gave me the results of his practice which concur in a great measure with my own, except that he fished with his bait paste made of soft herring roe worked up with bread crumbs and wool, a favorable substitute sometimes for the brandling.

In Germany the "angler usually prepares for his sport by 'ground-baiting' with a thousand or more angle-worms, twenty-four hours before he expects to fish, and while fishing he throws worms into the water."

While most of our sportsmen would probably indignantly object to having the carp classed as a game fish, it must be admitted that whether it should be so classed or not depends largely upon our definition of a game fish, and, as Goode says (1888, p. xiv), "no fish which is not of the highest rank as a table delicacy is rated by Americans as a game fish." He continues:

> The barbel, the dace, and the roach, the pets of the father of angling, classical in the pages of sportsmen's literature, are despised by new world authorities, and are now considered "coarse fish" even by English writers. Yet they afford excellent sport—sport which in England tens of thousands enjoy to every one who gets the chance to whip a salmon or trout line over preserved waters.

And so it is with the carp. Those who live where there is an abundance of other fish, such as bass and pickerel, or even of perch and

bream, will probably not abandon those fish for the pursuit of the carp, while, on the other hand, those who have done most of their fishing for buffalo, red-horse, mullet, or bull heads should welcome the carp with joy. How far in this country its capture is supplanting, or at least supplementing, the other of the coarser fishes in this respect has been best told by Dr. S. P. Bartlett (1903), of Illinois. For this reason I quote the greater portion of his paper:

The question has been asked me a great many times why it was that carp can not be taken with the hook and line. A great many persons have told me that they have used all kinds of bait and failed to get them to take it. These inquiries came to me as a surprise from the fact that hundreds daily fish for carp with hook and line on Quincy Bay and all along the Illinois River with great success.

I have found the best bait to be a dough ball made by boiling cornmeal to a good stiff mush, and then working the ordinary cotton batting into it until it becomes hard and stiff, and then rolling into little round pellets about the size of a marble. Bait prepared in this way will not be easily dissolved by the water. I use the ordinary Carlisle hook fastened on the end of a good strong line and three or four inches above the hook, attach quite a heavy sinker which will take the line to the bottom and allow the bait to flow up away from the bottom. Another good bait is the ordinary ship stuff from the mills, boiled stiff and dough rolled out in sheets and then cut up into little squares, perhaps three-fourths of an inch square. Fried potatoes, sliced raw and fried until they become stiff, not brittle, also is a fine bait. Anyone conversant with the hook and line at all, will have no trouble in carp if this bait is used as indicated.

On Quincy Bay I have seen as many as two hundred people fishing for carp along the shores, and nearly all of them get good fair strings. The carp when hooked is a very vigorous fighter, and care must be used that he does not break the hook or break out the hook from his mouth. I would advise the use of the landing net. They are daily taken on trout lines, using the same kind of bait.

Since your request for information as to the carp from an angling standpoint, I have given the matter a great deal of attention, and have been greatly surprised at the extent to which carp are caught with hook and line. From Cairo to Dubuque on the Mississippi River I have found shores at all the towns lined with people fishing for carp, all catching them. One day last week, from the lower end of Peoria, Illinois river, to water works point, a distance of three miles, I counted 1,103 people fishing with hook and line, and on investigation [it] developed that a large per cent of them were taking carp. The majority of those caught weighed a pound and as heavy as five pounds, all of them probably used as food. Permit me to introduce here a letter from one of the best known sportsmen in the State [Mr. M. D. Hurley, of Peoria, Ill.]:

"Carp fishing with hook and line has now taken its place with bass and other kinds of fishing. All along the river in this locality carp are being caught freely with hook and line this year, and to say they are gamey, is not half expressing it. For the past month I have made it my business to go along the river and take notes of this particular kind of fishing and talked with no less than 25 different persons who were busy catching carp, and in every instance I was told it was rare sport to hook a carp, as it was quite as much of a trick to land one as it was to land a bass; dip nets were used generally to land the carp, as the activity of the fish when jerked out of the water would tear the gills and free the fish quite often. The bait used when fishing for carp is dough balls and partly boiled potatoes, the latter being best in the opinion of the majority. The carp will bite on worms quite freely also, and in two instances, I found carp had been taken with minnows, something that has been considered impossible heretofore, but in these two cases I am certain it was

done, as I have the names of the parties who caught the fish. An old German who lives here goes daily to the river with a regular fly casting pole and reel to fish for carp. Of course he exchanges the fly for the regulation hook, but he used his reel in landing the carp, and says there is no finer sport than fishing for carp. This man uses partly boiled potatoes altogether and is very successful in taking carp in numbers daily. I have caught a great many carp myself with hook and line, using potatoes, dough balls and worms, and found that the partly boiled potatoes worked best, as the carp seemed to take that particular bait when they would not bite any other. As for the sport of catching carp with hook and line, I consider it equal to anything in the way of pleasure fishing, as the fish is gamey and will fight as hard against being landed as bass or other game fish and is to be handled with precaution on account of the tender gills, which will often tear when hooked by an inexperienced angler. In the past two years carp have become popular where they were unpopular, because of the wearing away of the prejudice that they were of no benefit to the angler on account of the belief that they would not take a hook. Now it is different, as the very ones who were so loud in their protest against the carp, have found great sport in taking them with hook and line, and it is wonderful to hear the change of sentiment as to the carp for food purposes. They are a good fish now and fit for a king in comparison to what was said of them while the prejudice still existed. To my mind the carp is a good fish for food purposes and is fast finding favor in the west in every way, now that the angler has found it is the coming fish for sport. Just at present, in the Illinois river, we have a world of all kinds of game fish and no end of carp, which insures the angler his full measure of sport until the end of time."

At Detroit and at Put-in Bay I have seen numbers of persons fishing from the wharves with hand lines for carp. The bait in most general use was a piece of boiled potato wrapped in mosquito netting to keep it on the hook. On the 25th of July, 1901, with this bait, I saw taken from the steamboat wharf at Put-in Bay a carp which measured 31.5 inches in length and the weight of which was estimated at about 16 pounds. This fish made a vigorous fight, and would have taxed the ingenuity of an expert angler if he had hooked it on a trout line and a light rod.

There is a tendency among sportsmen to deny the title of game fish to any that will not rise to a bait, either real or artificial. In such a category the carp certainly can not be included; it must be classed rather with those fishes that reward the quiet, "contemplative" angler, who must wait patiently until the fish bites, but who then has the same problem and must exercise the same skill in landing his game that he would have to display had he hooked one of those species generally acknowledged to be game fishes.

CARP CULTURE.

Carp ponds and pens may be divided primarily into classes according to the purposes for which they are used: (1) Permanent ponds or complements of ponds, used for breeding, rearing, and retaining the fish until such time as they are large enough to dispose of in the market; and (2) temporary ponds or other inclosures used only for holding carp from times when they are easily obtained until, on

account of their scarcity, the market value has risen to a point making their sale profitable. The terms permanent and temporary are thus used here, as it will be observed, not in the sense of the time of duration of the ponds, but as denoting the manner in which they are used. The latter sort correspond more or less closely in their function to the stock ponds on a well-equipped German carp farm. Either sort may be natural or artificial.

PERMANENT PONDS.

With a few possible exceptions carp culture has never been attempted in this country after the lines on which it is carried on so extensively in Germany. Most of those persons throughout the United States who aspired to carp culture at the time these fish were being distributed by the Government merely dumped the fish into any body of water that was convenient, or into any pond that could be hastily scraped out or constructed by damming some small stream, and thereafter left them to shift for themselves, possibly feeding them occasionally at first. That such efforts were not a success is no more to be wondered at than would be a man's failure if he attempted to establish a successful poultry farm merely by turning a few dozen fowls loose in the neighborhood of his home. Whether extensive and properly conducted carp farms would then, or would now, be profitable and pay a reasonable return on the capital and labor invested, is another matter, and will be considered a little farther on.

It is not proposed here to enter into an elaborate description of the methods employed by the successful European carp culturist. American readers who may be interested in the subject are referred to the excellent paper by Hessel (1881), which has been cited frequently throughout this report, and to the fuller account given in the translation published by the United States Fish Commission of the work by Nicklas (1886). Numerous works on the subject have been published in German, and references to them will be found in the bulletins named above; among the more recent books may be mentioned those by Susta (1888) and Knauthe (1901).

Some idea of the extent to which carp culture is practiced in Germany and the neighboring parts of Europe may be gained from the following extract quoted from Hessel (1881, p. 866):

> A celebrated establishment for carp-culture, with large, extensive ponds, was located, as early as the fourteenth century, near the town of Wittingau, in Bohemia, Austria. The first beginning of it may be traced back to the year 1367. At that time the lords of Rosenberg called into existence and maintained for centuries these establishments on a scale so extensive that to this day they are the admiration of the visitor, the main parts having survived, while the race of the Rosenbergs has long been extinct.
>
> The manor of Wittingau suffered greatly from the calamities of the Thirty Years' War, and with it, in consequence, its fish-culture. The latter only recovered the

effects of it after passing, together with the large estate of a rich monastery of the same name, in the year 1670, into possession of the Princes of Schwarzenberg, their present owners. The extent which carp-culture has reached on these princely domains will be seen from the circumstance that their artificial ponds comprise an area of no less than 20,000 acres. The proceeds amount to about 500,000 pounds of carp per annum. The ponds of the Princes of Schwarzenberg are probably the most extensive of the kind on the globe. They are usually situated in some undulating lowland country, where small valleys have been closed in by gigantic dams for the purpose of forming reservoirs. Similar establishments, though not equally extensive, are found in the provinces of Silesia and Brandenburg; as, for instance, near Breslau and Cottbus, in Peitz and Pleitz, which I visited last year. In Hesse-Cassel, Hanover, Oldenburg, Mecklenburg, and Holstein there are also many hundreds of ponds, none of them covering more than a few acres, but almost every large farm possessing at least one of them.

The well-appointed carp-cultural establishment has at least three kinds of ponds, each adapted for a particular phase of the industry. These ponds are usually made by throwing dams across small valleys, and by the aid of dikes, and are commonly fed by small streams flowing into them, by springs, or they may depend entirely upon the rains to keep them filled. These last are often spoken of as "sky-ponds," and are much more uncertain than the others. The ponds fed by streams are ordinarily protected from flooding by freshets by leading the main channel of the stream around them, so that the amount of water which flows into the pond can be regulated at will.

The classes of ponds are:

1. Spawning ponds. Shallow ponds in which the water is easily warmed by the sun, and suitable for the spawning fish.

2. Raising ponds. Ponds, usually of medium size, to which the fry are transferred and where they are retained, isolated from the larger fish, until they are a year or two old.

3. Stock ponds. Large ponds in which the fish are kept until they have reached a marketable size; this is usually considered to be when they have reached a weight of 2¼ to 2½ pounds. One reason that the young fish are reared for a time in the raising ponds is that in the stock ponds with the older carp are often kept a number of predaceous fish, such as perch, pike, etc., which are supposed to keep the carp in better condition by preventing them from becoming too lazy and sedentary. These fish would destroy the carp fry if the latter were put into the stock ponds while still small. The predaceous fish also form a secondary source of income.

Since the stock ponds are not always favorable for the wintering of the fish there are sometimes ponds especially adapted for this, and these are known as—

4. Winter ponds. These should be in sheltered localities, if possible, and should have a depth of at least 6 to 8 feet.

All the above classes of ponds are constructed upon the same general principle. Ditches from the various parts of the pond lead into other

ditches which are deeper, and these finally lead into a still deeper pit (the "fish pit"), which is situated at the place of outlet, usually near the dam. When it is desired to drain the pond, the water is drawn off gradually, the fish work down into the ditches, which completely drain the pond, and so they all come finally into the fish pit, whence they can be taken with nets. In a properly constructed pond it is possible to draw all the water from the pit, and thus completely drain the pond. It is common on many farms to have a curious "rotation of crops;" the fish ponds are drained and turned to agricultural purposes for a season or two, when by closing the outlet gates and allowing the water to fill them again they are reconverted into ponds, and pisciculture is resumed. Such a proceeding is said to have a salutary effect upon both industries.

TEMPORARY PONDS AND PENS.

Although there are very few, if any, carp-cultural establishments in this country conducted on the principles of those that have just been described, there is, nevertheless, an increasing number of ponds being constructed and used for the temporary retention of the fish. This is true especially in the Lake Erie district. These inclosures vary all the way from the simplest pens, not calculated to hold more than one-half ton to a ton of carp, to extensive ponds covering large areas and constructed and maintained at a considerable expense.

These temporary inclosures may again be divided into two classes: (1) Those in which the level of the water is not under control, but varies with the changing level of the surrounding waters; and (2) those in which the water level in the ponds can be artificially maintained at any desired height.

Under the first class the simplest kind is that already mentioned (p. 612) as being used when it is desired to retain the fish only a very short time—a few days to a week or so at most. These are the ordinary live-cars or crates—large boxes constructed of rough boards with cracks between, which allow the access of plenty of fresh water. When the fish have been placed in these, the covers are fastened down and the cars towed out to where the water is deep and certain to be fresh—well out in a stream, if possible. The cars are weighted with heavy stones, so that they float with their tops just at the surface of the water. Fish kept in cars are seldom fed, unless it is necessary to keep them much longer than is usually the case. When they are taken out, dip nets are employed.

A common method of constructing inclosures which will accommodate a larger number of fish, and in which they may be kept indefinitely, is to build out into a stream, or from the shore of a bay or lake where the conditions are suitable, a sort of rough picket fence around three sides of an area, the shore usually forming the fourth

boundary (fig. 2, pl. II).[a] This fence consists of rough boards driven into the mud a short distance apart, and supported at intervals by strong stakes driven firmly into the bottom. It is necessary to have the top of the fence several feet higher than the highest water, to prevent the fish from leaping out. A woven-wire netting 2 to 3 feet high is often added to the top of the fence for this purpose; it is not practicable to use the wire netting under the water, as the fish would become badly bruised in attempting to get through it, or by dashing into it without seeing it. The pens may be of any size, from small ones, which will accommodate only one or two hundred fish, to those covering an extent of some 2 or 3 acres. Larger ones than this are probably not practicable on account of the difficulty that would ensue in attempting to get the fish out of them; obviously the water can not be drawn off and the pen drained, so the only way of taking the fish is with a seine. This is done by setting the seine around the perimeter of the area, close to the fence, and then hauling it to one corner of the inclosure, where the fish can be gathered into the bag of the seine (fig. 2, pl. II).

As a rule there is not enough natural food in these pens for the sustenance of the fish, and in order to keep them from falling away greatly in weight it is necessary to supply them with food. The necessity of removing the fish with a seine makes it impracticable to build the pens where there is plenty of vegetation to supply the fish with natural food, since much vegetation would interfere greatly with the seining.

Pens should be built in places sheltered as much as possible from storms, for the high waves are apt to break down the fence and allow the fish to escape. Unusually high water and severe storms caused great damage in this way in Sandusky Bay and vicinity in the summer of 1902, one pen, in which there were said to be 40 tons of carp at the time, being broken down in places so that all the fish were lost.

Portions of marsh which have comparatively narrow openings leading into them are sometimes converted into ponds by throwing embankments, or more often building board stockades, across the narrow places. Such ponds usually have the advantage of containing plenty of natural food, but trouble usually arises when it comes time to take the fish out, as the places are not adapted to the use of a seine. In some cases the embankment or fence, with a convenient gateway, is constructed early in the spring and the gateway is left open until a large number of fish have entered the shallow water of the inclosure for the purpose of spawning, after which the gateway is closed and the fish are entrapped, to be seined out at leisure. At one or two places great areas of marsh were cut off in this way and the fish were prevented from returning to the larger open waters; but this was of

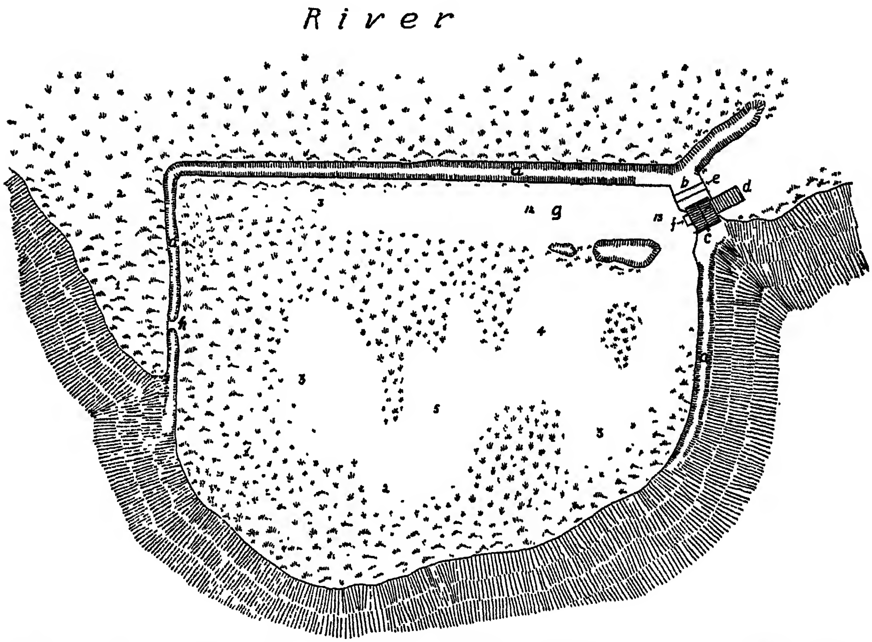
[a] A photograph of a carp pen similar to this is shown in the Illinois fish commissioner's report for 1900-1902.

little avail, since the places were so large and the conditions so varied that it was practically impossible to get the fish out.

There remain still to be considered those ponds in which the water can be maintained at a definite height irrespective of the varying level of the neighboring waters. Under suitable conditions they could probably be constructed best in valleys and natural depressions according to the plans already outlined as being in general use in carp-cultural establishments. Under the conditions of our fisheries, however, it is a matter of great economic importance that these ponds should be as near to the fishing grounds as possible, and as the land there is low and marshy the ponds must for convenience be constructed in or along these marshes. For this reason the problems presented are very different from those met with in the building of ponds on higher ground. The greatest difficulty comes, of course, in the matter of the drainage of the pond, since its deepest portions of necessity lie below the level of the outside waters. An idea of the methods that have been devised can probably best be conveyed by giving brief descriptions of two or three ponds which have now been in use for several years.

Along the marshy shore of the Portage River, a mile or two above Port Clinton, Ohio, is a successful carp pond covering some 30 to 35 acres, and owned and managed by two brothers, who also conduct at the same time a fruit farm immediately adjacent to the pond. The site of the pond was originally a marsh, flooded by backwater from the river, where the carp commonly came in to feed and to spawn. It was first converted into a pond (see diagram, p. 628) by throwing up an embankment along the river side, cutting it off from the river, but still leaving it connected by an open gateway protected by a screen or grating. The inclosed water was at the same level as the outside water, and as the level rose and fell a stream rushed in and out through the gateway. This plan was found to be unsatisfactory, as the impounded fish crowded about the grating, neglecting to feed, and at the same time becoming badly bruised by their contact with the bars. The embankment was then raised and the gateway closed, so that the water in the pond could be maintained at a level 1 to 2 or 3 feet or so higher than the mean level of the river, while at the same time the increased height of the water caused it to spread farther back over the land, enlarging the pond, and encroaching upon a neighboring cornfield, a large portion of which was thus converted into marsh. The principal embankment was easily raised by having a shovel-dredge make a cut along the inner side, the excavated mud being deposited on the outer side of the cut to form the embankment. The lower portions were built with a scraper at a time when the river was especially low, at which periods the pond can be practically drained of water. During rainy seasons springs kept the water well up to the desired

level, but during drier times these were not sufficient, and it became necessary to pump water in from outside. This was done for a season or so by means of an "elevator" in a wooden trough or chute in which run endless-chain belts with closely fitting boards forming a series of buckets as they move upward through the trough. (See fig. 2, pl. III.) The motive power at first was a span of horses, but later a 7-horsepower gasoline engine was installed, which does the "pumping" or elevating much more expeditiously. The amount of pumping required to keep the water at the proper height and sufficiently fresh



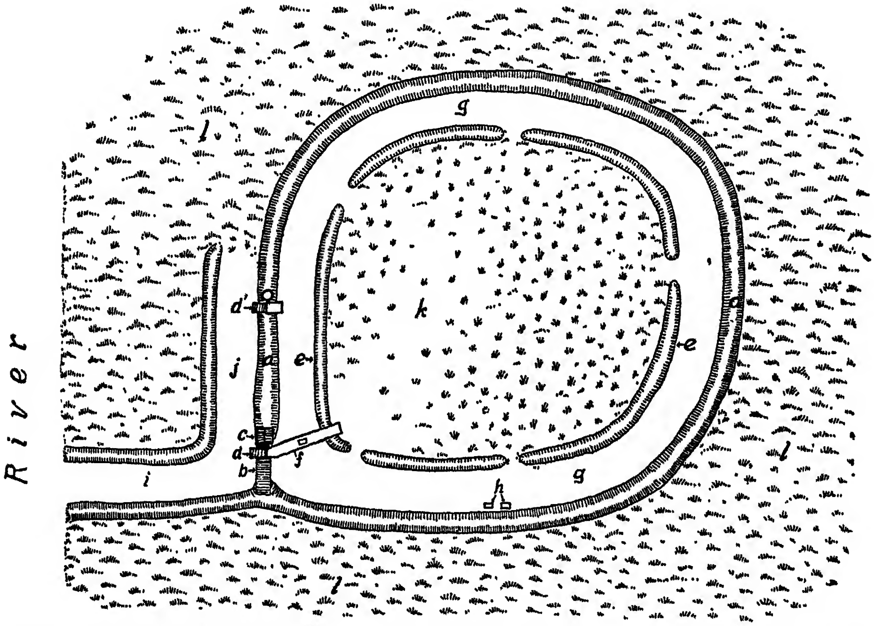
Diagrammatic plan of carp pond near Port Clinton, Ohio: *a*, embankment; *b*, dam; *c*, engine-house; *d*, water elevator; *e*, chute through which fish are slid into pond; *f*, chute through which fresh water enters pond; *g*, dredge-cut; *h*, outlet. The figures indicate depth of water.

depends very closely upon the weather conditions and to some extent upon the number of fish in the pond. It is seldom that so much as two or three hours a day is required.

The water in the dredge cut is about 12 feet deep, but in other portions of the pond there are few places more than 5 or 6 feet in depth, and much of the water is considerably shallower. In all the shallower parts is a rank growth of aquatic vegetation (sweet flag, cat-tails, deer's tongue, wild rice, bulrushes, burr reed, etc.) which supplies so much natural food that the fish are seldom or never fed artificially. With the maintenance of the water level, thus avoiding the rushing of the water in and out through a grating, the fish remain distributed most of the time throughout the marshy parts of the pond

where food is abundant. An exception to this is when a stream of water is pumped in steadily for a time; then the fish begin to come from distant parts of the pond to the place of the incoming stream, as has already been described (p. 560). This tendency of the carp to gather around the place where the fresh water comes in is taken advantage of when it is desired to seine them out, the net being hauled in the dredge cut when the fish have congregated there.

Another pond, near the Raisin River, below Monroe, Mich., and but a short distance from Lake Erie, differs in some ways in method of



Diagrammatic plan of carp pond near Monroe, Mich.: *a*, outer embankment; *b*, dam; *c*, engine house; *d*, *d'*, water elevators; *e*, inner embankment; *f*, chute arranged for carrying water either into dredge cut (*g*) or into central area (*k*); *g*, circular dredge cut; *h*, outlets; *i*, dredge cut from river; *j*, outside dredge cut; *k*, central area (water 1 to 2 feet deep); *l*, marsh (barely covered with water).

construction from the one just described, and for this reason seems worthy of mention. (See fig. above.) This pond is smaller than the other, and is of interest as showing how a pond can easily be built in the middle of an extensive flat marsh. This was done by starting with a dredge at the river and cutting a channel straight into the marsh for a short distance. A large circle was then made, the greater part of the mud brought up being placed on the outer side of the cut, thus forming a high embankment, while on the inner side a smaller one was built up, in which, however, several breaks were left. After it had completed the circle the dredge was taken back outside and a short cut was made on the outside and parallel to the outer embankment. When a dam had now been built at the only opening, it was possible to raise

the water in the interior to a height of 2 or 3 feet above that in the surrounding marsh. This was here accomplished in the same way as at Port Clinton, except that steam power was used for the purpose instead of gasoline engines.

The pond then consists of a ditch 7 to 10 feet deep around the entire circumference, the water over the central area having a rather uniform depth of 1 to 2 or 3 feet. The fresh water that was pumped in was originally turned immediately into the circumferential ditch, or could be carried by a wooden flume over into the central area. The first year the pond was used there was found to be great mortality among the fish, a condition probably due to the large amount of freshly exposed soil with which the water came in contact, so that it became charged with humic acid and other products of organic decay until it was unfit for the fish. This condition continued in spite of the fact that fresh water was continually pumped in, especially during the warmer weather, and it was found later that the water at the bottom of the ditch was very foul and with a bad odor. In the succeeding year flumes were arranged so that the fresh water was carried at once to the bottom of the ditch, and the conditions were found to be much improved. There would probably have been less danger in any case during the second year, as the soil had undoubtedly by that time become very well leached out.

Here, as in the pond previously described, it was found that the fish gathered around the stream of incoming water, and here also advantage was taken of this fact in capturing them. The pond could be drained, if necessary, by changing the elevator over to the inner side of the embankment and discharging the water from the pond back into the surrounding marsh.

There is one other style of pond in use in this region that should be mentioned, in order to make the present account complete. These have been constructed especially by the farmers along the southern shore of Sandusky Bay. They are situated on higher ground than those ponds which have just been described, ground that is usually at least a few feet above the mean level of the bay, and are formed simply by scraping the soil out of an area covering usually not over one-fourth to one-half acre, the soil that is removed being used to build the embankments. The water is supplied by windmills or, in a number of cases, by artesian wells. This water would seem not to be well adapted to carp ponds, being cold and strongly mineral, with a very decided sulphurous taste; and yet the carp are said to do very well in it. As the ponds contain practically no natural food supply, the fish have to be fed regularly to keep them from falling away greatly in weight. For this purpose a variety of things are used, but shelled corn is probably employed more than anything else. In one such pond, which contained about 10 tons of fish, the carp were said to have been fed

very largely upon sowed corn, which was cut when about 1 to 2 feet high and thrown into the pond. The proprietors claimed that the fish would dispose of a load—supposedly a wagonload—of this in four or five days. At this same place the first year the pond was used the fish were not fed at all, and when marketed there was only half the weight of fish that had been put in.

THE VALUE OF CARP PONDS.

It is safe to say that under existing conditions, where at certain seasons of the year three or four men with a seine can obtain adult carp in almost limitless numbers with comparatively little trouble, carp culture in the ordinary sense would not be profitable. At least this is true in regions such as Lake Erie and Lake St. Clair, where carp are so abundant. That regular culture ponds, in which the fish are reared from the egg until of a saleable size, could not be conducted with profit in proximity to some of the large cities which constitute the principal markets for carp is not so certain. Undoubtedly, as the demand for carp grows, as it surely must, such will be the case.

On the other hand, there is no doubt of the great gain to be made by taking carp in the spring and early summer, when they come into the shallows and marshes in such great numbers, and holding them over to fall or winter, when the market price has sometimes multiplied fully tenfold. Let us take, for example, a suppositious case, based, however, on actual conditions. A moderate sized pond could readily accommodate, let us say, 50 tons of carp, and these could be obtained with comparative ease during the spring. At this season, when the fish are most plentiful, the price is often as low as 30 cents per hundred pounds, so that the market value of the whole 50 tons would be but $300, even if they could be disposed of at all at that time; for it often happens that when the fish are so plentiful many more are brought in than can be used, and great numbers bring the fisherman almost nothing, being only sent to be made into fertilizer. Now let us suppose that instead of disposing of these fish at such an unsatisfactory figure the fisherman pens, or otherwise holds them over the summer. Under at all favorable circumstances the loss in that time surely ought not reasonably to be greater than 10 per cent of the total number of fish impounded, even allowing for the damage to fish by handling.

Indeed, in a properly conducted pond, there should be no loss in weight at all. The growth of the living carp, if properly fed and cared for, should adequately offset the loss of individuals. For the sake of fairness, however, we shall assume a loss amounting to 10 per cent of the weight, and that the total weight of fish recovered from the pond in the fall amounted to one-tenth less than that put in—in other words, to 45 tons. Now, in the late summer, fall, and winter months it is not at all unusual for the price of carp to go to 2, 2½, or

even 3 cents per pound, a price ten times as great as that of the spring. Many of the owners of carp in ponds and pens wait only for the market to reach 2 cents per pound, and then fish their ponds and sell the fish. If we market our 45 tons at this moderate price, they now bring us the sum of $1,800, in comparison with which their original value was insignificant.

It is needless to say that not all who make this venture are so successful. From inexperience or ignorance of the conditions required some of the ponds are very unfit for carp, and the mortality is much greater than we have estimated above. Or in some cases, especially in the pens, the fish have no natural food, and they can be maintained in good condition only by feeding them artificially. The cost of this must, of course, be deducted from the profits, and may amount to a considerable item. Furthermore, the initial cost of constructing a pond may constitute a relatively large investment, and account must be made also of the necessary labor to maintain it and to care for the fish. All these items vary greatly with local conditions, for whereas a pond may be constructed and operated very economically in one locality, in another place it may prove very expensive. Certain it is, however, that small ponds are each year proving an acceptable source of subsidiary income to many farmers whose land is favorably located, while individual fishermen and fishing companies are yearly going into this business of holding over carp on a more and more extensive scale.

CONCLUSIONS.

As was stated in the introductory remarks at the beginning of this report, the main purpose of the investigation was to determine, if possible, whether the introduction of the carp into the United States had proved a benefit to the country or whether the fish had turned out to be so detrimental to the fisheries and other interests that it must be considered as a nuisance. In other words, have the twenty-five years or more that the carp has lived in our waters, and in which it has increased to such a surprising extent, justified the belief of those who were instrumental in its introduction that it would fill a place in the economics of our fisheries that could not be taken by any of our native fish; that it could, with little trouble and at small expense, be artificially raised in ponds and other small bodies of water unsuitable for the culture of any equally desirable native species, thus affording a cheap and ready supply of fresh fish to many who would otherwise be unable to have any fish at all; and finally that it would populate such of our lakes and streams as were unfavorable for inhabitation by finer species, and contained only buffalo, suckers, and the like?[a]

[a] The good qualities claimed for the carp, which led to its introduction, will be found enumerated on page 544.

As regards the culture of the carp in this country, we find that, although there was for a few years an enormous demand for the young fish—hundreds of thousands of which were yearly distributed free by the United States Fish Commission and by many of the state commissions—their culture was soon abandoned in nearly all cases and the fish allowed to escape into the open waters of the vicinity. There are a number of reasons to account for this. People were expecting too much. They rushed into carp culture in entire ignorance of the conditions requisite for its successful operation, and, such being the case, it is no wonder that they were disappointed in the results and that their attempts were failures. In the second place, there was also a general disappointment in the qualities of the carp as a table fish. Undoubtedly, as in the case of its culture, too much had been expected, though perhaps not without some justification. Still, the bulletins that had been published and distributed made frequent mention of the muddy flavor of the carp when grown under unfavorable conditions, and emphasized the necessity of keeping such fish for a time in clear water before killing them. Then, too, the fish were often eaten at the wrong season, during the spring and summer months, when their flesh is admittedly poorer in quality than in the fall and winter. This is true of most fish that live in rather shallow and sluggish waters, and even black bass are seldom caught and eaten at these seasons. Perhaps even more important was the matter of cooking. As has been mentioned in the body of the report, it is generally conceded that carp should be cooked in special ways, and the Germans especially have many elaborate dishes which they prepare from its flesh. Most of those who tried the fish here cooked it as they were accustomed to cook our native fishes, and decided that it did not compare favorably with these, though, according to the statements published by Smiley (1886), many appeared to be very enthusiastic about it. Finally, another important factor which probably led to the abandonment of pond culture in many cases was the increasing abundance of carp in the rivers and other open waters. It was found that what fish were wanted could be obtained with less trouble from the open waters than they could be raised.

The whole question was admirably summed up in the Report of the Michigan Fish Commissioners for 1884–1886 (Michigan, 1887, pp. 41, 42). This report not only contained much cool-headed advice to those who were contemplating launching into carp culture, but was almost a prophecy of the outcome of the introduction of carp into the country. After insisting that the carp will not be a success unless properly cared for, the report continues:

From the fact that carp could be successfully grown in warm and muddy waters, it was inferred that they would be just the fish to plant in our comparatively shallow lakes throughout the State, and from the published accounts of their amazing fertil-

ity, and rapid growth, it was confidently expected that in a very short time a large food supply would be furnished.

While we believe that the carp will eventually prove a valuable addition to our food fishes, and especially fill a want amongst the rural population, still we would caution those desiring to engage in this industry to go slow, to test its value for food in comparison with our native varieties; to see whether they like carp to eat before they spend any considerable sums of money in the construction of ponds, etc.

Nothing so much injures any enterprise as overestimating its importance. Estimates are still wanting as to the cost per pound for raising carp, and the fact that they can be so readily procured must in a short time make them so plentiful in the markets as to bring the price below the cost of production, if one-half of those designing to engage in their culture should realize their expectations.

There can be no doubt that the carp is a nutritious and healthy food fish, but there is a doubt whether they will please the taste of the general public who have been accustomed to the taste of our native fish. In the trial made by the Commission and their friends, when direct comparison has been made with our native fish by cooking them in the same manner and at the same time, the decision was that they seemed inferior to the fish with which they were compared, namely, the black bass and the wall-eyed pike. But in the regions where fish, even poor ones, are a luxury they will provide a great boon. In a State so exceptionally well supplied, however, with the finest fresh-water fish in the world, as our State is, it is doubtful if the carp will become either a favorite food or a source of profit for many years to come.

Although the carp did not fulfill expectations in the matter of pond culture, it has more than done so in the way it has adapted itself to conditions found in this country and the rapidity with which it has multiplied in our waters; and we find now that, instead of being generally used throughout the country and especially in those sections where it was thought it would be most appreciated on account of the poverty of the streams or the poor quality of their inhabitants, it is being sold almost entirely to the poorer classes of people in our large cities. The Illinois River, together with the other rivers of the Mississippi drainage system, is one of those localities in which it was thought that carp would be a most valuable accession, and such has turned out to be the case, though not in the exact way originally expected. Although practically not used at all for home consumption, it has nevertheless added very appreciably to the resources of the region.

With our constant immigration of foreigners and the formation and growth in our large cities of great foreign settlements, the problem of supplying these multitudes with cheap yet wholesome food becomes very great, and anything which helps to meet this demand is of great value to the country. From this point of view there is no doubt of the value of the carp and the benefit to be derived from its introduction. To pervert a common saying, in those places to which it is best suited it has made two fish to grow where but one grew before.

But now come the sportsman and the commercial fisherman, who maintain that, while all that has been stated may be true, the presence of the carp is entirely supplanting the fish which was there before,

and that that one fish was of more value than the two carp which have taken its place. This is especially true of such waters as the Great Lakes, and others that were well supplied with good native fish. Furthermore, the sportsmen and others claim that in various ways the carp does more than enough damage to offset its value in other respects. By these persons it is made responsible especially for the great decrease of water-fowl in recent years. These and other charges have been considered in the body of the report, and need not be discussed in detail here. In most cases the reported damage has been either greatly exaggerated or is entirely unfounded. Thus it was found that carp probably have little or no share in causing the decrease of the native fishes commonly taken for sport or for food; and that in the case of the black bass, at least, there is evidence indicating just the opposite—that the bass have actually increased in numbers in some places from having the young carp to feed upon. In the matter of uprooting vegetation, making the water continually roily, and injuring—possibly even completely destroying in some cases—the regular feeding grounds of the migrating ducks—in these cases the evidence goes very largely against the carp, though its effects have undoubtedly, in many instances, been greatly exaggerated, and more has been charged against the fish than it rightfully deserves. In certain places, such as reservoirs and lakes supplying water to cities, etc., there is no doubt that the carp is an unmitigated nuisance, and that its presence is undesirable. Nor can it be considered suitable for the cold, clear lakes of the north, such as are found in northern Wisconsin and in Canada; and fortunately the conditions in these are so unfavorable that it will probably never become so abundant in them as to cause much damage by destroying vegetation and roiling the waters.

Against these charges as to its detrimental influence must be set the things in its favor. Chief among these is that already mentioned—the value of the carp as a source of revenue to the fishermen in the regions where it occurs, and as a cheap food for the poorer class of people who can not afford a better fish. It is impossible to express in dollars and cents the beneficial results and the damage done and thus to compare them directly. The value of the carp fisheries of Lake Erie and the Illinois River region for 1901 was estimated at $342,000 (p. 619, footnote); but there were no data for the rest of the United States. And no monetary value at all can be fixed for the damage done. It seems quite safe to say, however, that if the question were to be considered in this manner the benefits would far surpass the damage. Two other claims in the carp's behalf, which may prove to be of considerable importance, ought also to be mentioned. These are its destruction of the fluke-worm (*Fasciola hepatica*), and of the larvæ of noxious insects, especially mosquitoes. It is possible also that in

rivers, below cities, it may do important service as a scavenger, destroying the germs of certain human diseases, as it does the larval and encysted stages of the liver fluke.

Even were it possible to estimate the money value of the damage done, such a basis would not be an entirely fair one for comparison. Should the carp help to hasten the extermination of any of our water-fowl, or if it destroys the beauty of lakes, as is claimed, this is a harm which can not be reckoned in dollar and cents. As has been pointed out elsewhere, however, there are other and more influential factors at work in the destruction of the water-fowl; and in the other case special measures of prevention and protection must be employed.

And when we have decided whether the carp does more harm than good, we still have the real question before us. The essential problem is this: The carp is here, and here to stay; what are we going to do with it? How can we make the most of its good qualities and prevent it from doing damage? Even were such a course desirable, the extermination of the carp in our waters is out of the question. Mr. Townsend, in some remarks before the American Fisheries Society (Transactions of Thirtieth Annual Meeting, 1901, p. 123) stated the case well when he said:

> We hear a great deal from sportsmen's clubs and from other sources as to how the carp can be exterminated. It can not be exterminated. It is like the English sparrow, it is here to stay. At a meeting of the American Ornithologists' Union a while ago, one of our foremost ornithologists stated that the European sparrow could not be exterminated in this country. I think it is the same with the carp. It is here to stay and we can not exterminate it any more than we can exterminate the green grass of the fields. I do not wish to pose as an advocate of the carp—I prefer other fish for myself—but I maintain that the carp has a place in good and regular standing in our big eastern markets, and I do not think that our great republic with its rapidly increasing population, can afford to sneer at even so cheap a source of food.

In the course of my investigations and inquiries I met frequent propositions that the government, or the respective state governments, should offer a bounty on carp. Nothing could be more futile than this, as has been abundantly illustrated in the case of the English sparrow. The best bounty that can be offered is an increasing market—a growing demand that will make fishing for carp a profitable business. The case in Lake St. Clair is a good illustration. While there I heard the bounty proposition frequently advocated by sportsmen who came to the flats to fish and hunt. But a shrewd resident said, let the state amend the laws so as to allow the taking of carp in nets, and there will soon be enough people fishing for them to reduce their numbers. Since then the laws have been changed so as to allow seining in the lake, and if the removal of enormous quantities of the fish (see p. 614) will do anything toward permanently reducing their numbers, such certainly ought to be the result there now. The lines along which it

seems that the market for carp may in the future be further developed have been pointed out and discussed in the section dealing with its food value and uses.

In another place was mentioned the possible amusement and recreation to be had in taking carp with hook and line. I am aware that the American sportsman will scoff at the very idea, and would regard the pastime with disdain. I wish merely to quote in its defense a paragraph from Goode's American Fishes (Goode, 1888, p. 412), in which he treats of the strenuousness of the average American angler:

> There is a kind of pleasure known to English anglers which is cultivated by but few of those who are called by the same name in America—the quiet, peaceful delight of brook-fishing in the midst of the restful scenery of the woods and the meadows. It is difficult to imagine a thorough disciple of Walton chumming for striped-bass in the surf at Newport or trolling for Muskellunge among the Thousand Islands, drailing for Blue-fish in the Vineyard Sound, or tugging at a tarpum-line in the Gulf of Mexico. The muscular exertion, the excitement, the flurry and noise, make such sports more akin to the fiercer pursuits of hunting than to the contemplative man's recreation. The wisest, best and gentlest of anglers, those who have made the literature of angling akin to poetry, have not, as a rule, preferred to make a violent exercise of their fishing.

Nothing has been said in the present report about protection for the carp in open waters, since, whatever may be the opinion as to the fish's desirability, protection for it does not seem to be needed. I am of the opinion, however, that the phenomenal increase of the carp in those waters where it has been longest will soon reach its maximum, if it has not already done so, and that as the various factors become adjusted a more stable balance will be reached. It is conceivable that then persistent fishing may greatly reduce its numbers.

And now, should I attempt to sum up the principal results of the investigation in a single paragraph, I should say that, whereas the carp undoubtedly does considerable damage, from the evidence at hand it seems reasonable to conclude that this is fully offset by its value as a food fish and in other ways; that it can not be exterminated, and that the problem is how to use it to the best advantage—suggestions for which have been offered. Efforts should be directed to encourage utilization of the fish in all ways possible, since it appears to be a resource as yet comparatively undeveloped.

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STATISTICS OF THE FISHERIES OF THE GREAT LAKES IN 1903.

PREPARED IN THE DIVISION OF STATISTICS AND METHODS OF THE FISHERIES.

A. B. ALEXANDER,
Assistant in Charge.

STATISTICS OF THE FISHERIES OF THE GREAT LAKES IN 1903.

The report of the fisheries of the Great Lakes here presented is for the calendar year 1903. The inquiry on which it is based was made by the statistical agents of the Bureau in 1904, beginning the latter part of May. The statistics obtained have already been published in Statistical Bulletin No. 166.

Earlier publications relating to the fisheries of the Great Lakes are the following:

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Statistics of the Fisheries of the Great Lakes. Report U. S. Fish Commission, 1901, pp. 575–657.

GENERAL STATISTICS.

The number of persons employed in the fisheries of the Great Lakes in 1903 was 9,333, including 1,249 on vessels fishing and transporting, 6,384 in the shore or boat fisheries, and 1,700 engaged as shoresmen in the wholesale fishery trade and in other occupations in connection with the fisheries. In the fisheries of the various lakes the number of persons employed was as follows: Superior, 918; Michigan, 3,241; Huron, 1,704; St. Clair, and the St. Clair and Detroit rivers, 355; Erie, 2,727; and Ontario, including the St. Lawrence and Niagara rivers, 388. Compared with the returns for 1899, the year for which the last canvass was made, there was an increase of 305 persons in Lake Superior and 463 in Lake Huron, but a decrease of 1,001 in Lake Erie, and small decreases in the other lakes; resulting in a total decrease of 337.

The amount of capital invested in the fisheries and related industries was $7,474,422, which was apportioned among the lakes as follows: Superior, $596,322; Michigan, $3,489,187; Huron, $851,639; St. Clair, $239,885; Erie, $2,196,397; and Ontario, $100,992.

The investment included 206 fishing and transporting vessels of 3,846 net tons, valued at $690,450; outfit of vessels valued at $155,256; 3,170 boats and gasoline launches, valued at $317,060; fishing apparatus used on vessels and boats to the value of $1,322,570; shore and accessory property valued at $2,869,607, and cash capital amounting to $2,119,479. The apparatus of capture consisted principally of 4,528 pound nets and trap nets, valued at $585,998, and 101,890 gill nets, valued at $642,961. The investment, as compared with the returns for 1899, has increased in all the lakes except Lake Erie, the total increase being $856,706.

The products of the fisheries amounted to 86,194,817 pounds, having a value to the fishermen of $2,745,501. The yield of Lake Superior was 13,205,013 pounds, valued at $343,671; of Lake Michigan, 33,579,498 pounds, valued at $1,090,550; of Lake Huron, 14,455,209 pounds, valued at $450,318; of Lake St. Clair and the St. Clair and Detroit rivers, 521,941 pounds, valued at $21,594; of Lake Erie, 23,188,556 pounds, valued at $780,015; and of Lake Ontario and the St. Lawrence and Niagara rivers, 1,244,600 pounds, valued at $59,353.

The principal species taken, and the quantity and value, including fresh, salted, and smoked fish, were: Herring and chubs, 32,157,329 pounds, $815,428; lake trout, 16,131,938 pounds, $722,525; suckers, 6,694,040 pounds, $121,576; yellow perch, 6,201,723 pounds, $139,670; white-fish, 3,813,259 pounds, $223,472; blue pike, 4,981,422 pounds, $191,386; wall-eyed pike, 3,076,147 pounds, $168,284; German carp, 4,237,643 pounds, $71,285; bluefin white-fish, 2,729,968 pounds, $83,749; and saugers, 1,940,355 pounds, $47,697. Menominee and long-jaw white-fish, cat-fish and bullheads, sturgeon, fresh-water drum, and various other species were also taken in considerable quantities. Since 1899 the products have decreased 27,532,423 pounds in quantity, but have increased $134,062 in value. The greater part of the decrease in quantity was in the catch of herring. There has also been considerable falling off in the catch of cat-fish and bullheads, fresh-water drum, saugers, sturgeon, white bass, white-fish, and yellow perch. A few species, including German carp, suckers, lake trout, and bluefin white-fish have increased considerably in both quantity and value. Bluefin white-fish were not until within recent years taken in any of these lakes except Lake Michigan, but in 1903 the greater part of the catch, or 2,095,304 pounds, valued at $58,887, was obtained in Lake Superior.

The following tables present, by lakes, the number of persons employed, the amount of capital invested, and the quantity and value

of the products of the fisheries of the Great Lakes in 1903; also a comparison of their extent in various years from 1880 to 1903:

Table showing by lakes the number of persons employed in the fisheries of the Great Lakes in 1903.

How employed.	Superior.	Michigan.	Huron.	St. Clair.[a]	Erie.	Ontario.[b]	Total.
On vessels fishing	169	362	51		621	8	1,211
On vessels transporting	6	2	16		12	2	38
In shore or boat fisheries	613	2,077	1,450	303	1,591	350	6,384
Shoresmen	130	800	187	52	503	28	1,700
Total	918	3,241	1,704	355	2,727	388	9,333

[a] Includes St. Clair and Detroit rivers. [b] Includes St. Lawrence and Niagara rivers.

Table showing by lakes the apparatus and capital employed in the fisheries of the Great Lakes in 1903.

Item.	Superior.		Michigan		Huron.	
	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	20	$68,700	64	$184,100	8	$24;000
Tonnage	508		1,116		129	
Outfit		22,637		55,532		10,795
Vessels transporting	1	7,000	1	1,900	7	21,700
Tonnage	131		10		59	
Outfit		1,094		10		2,200
Boats	322	20,528	1,298	144,854	[a] 606	45,173
Gasoline launches	35	21,150			22	22,550
Apparatus—vessel fisheries:						
Pound nets			5	925		
Gill nets	4,455	63,538	27,770	167,760	2,222	25,625
Lines				1,155		
Apparatus—shore fisheries:						
Pound nets and trap nets	218	27,793	975	198,035	1,685	176,495
Gill nets	5,714	63,700	20,875	101,994	3,907	25,901
Seines	8	335	44	2,884	18	608
Fyke nets	25	250	2,561	32,395	443	12,583
Lines		297		2,318		183
Crawfish pots			4,560	1,100		
Other apparatus		268		745		1,211
Shore property		156,332		1,241,500		387,115
Cash capital		142,700		1,352,450		95,500
Total		596,322		3,489,187		851,689

Item.	St. Clair.[b]		Erie.		Ontario.[c]		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			100	$353,650	2	$4,000	194	$634,450
Tonnage			1,733		20		3,506	
Outfit				57,928		510		117,402
Vessels transporting			2	25,000	1	400	12	56,000
Tonnage			126		14		340	
Outfit				4,500		50		7,854
Boats	150	$3,150	467	22,208	226	7,497	3,069	243,410
Gasoline launches			39	26,950	5	3,000	101	73,650
Apparatus—vessel fisheries:								
Pound nets							5	925
Gill nets			28,755	143,115	620	2,920	63,822	402,958
Lines								1,155
Other apparatus			70	210			70	210
Apparatus—shore fisheries:								
Pound nets and trap nets			1,469	172,805	176	9,945	4,523	585,078
Gill nets			6,396	37,466	1,176	10,942	38,068	240,003
Seines	6	890	110	8,040	8	205	194	12,462
Fyke nets			307	16,490	509	7,161	3,845	68,879
Lines		325		1,377		1,526		6,056
Fishing machines					6	600	6	600
Crawfish pots							4,560	1,100
Other apparatus		636		273		16		3,149
Shore property		141,805		919,635		23,220		2,869,607
Cash capital		93,079		406,750		29,000		2,119,479
Total		239,885		2,196,397		100,992		7,474,422

[a] Includes 5 steam tugs under 5 net tons, valued at $4,600.
[b] Includes St. Clair and Detroit rivers.
[c] Includes St. Lawrence and Niagara rivers.

Table showing by lakes and species the yield of the fisheries of the Great Lakes in 1903.

Species.	Lake Superior.		Lake Michigan.		Lake Huron.		Lake St. Clair.[a]	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass			5,577	$494				
Buffalo-fish			1,202	43			800	$2
Cat-fish and bullheads	588	$18	61,420	2,048	155,826	$5,444		
Dog-fish or bowfin					16,191	297		
Eels			727	56	1,211	58		
Fresh-water drum			41,650	666	47,426	309	10,200	126
German carp			535,080	8,889	37,491	954	102,000	1,812
Herring, fresh	4,307,422	36,566	[b]4,373,867	106,973	1,144,094	14,561		
Herring, salted	435,383	9,118	9,487,100	240,163	3,496,233	68,141		
Herring, smoked			2,650	212	640	40		
Ling or lawyer, fresh			119,505	1,509	80	2		
Ling or lawyer, salted			900	18				
Minnows							3,000	800
Muskellunge					420	24	3,000	405
Pike and pickerel, fresh	10,866	218	90,634	5,205	145,407	6,980	20,200	1,185
Pike and pickerel, salted					1,610	30		
Pike perch (blue pike)								
Pike perch (wall-eyed)	93,831	3,451	216,483	11,765	1,598,674	89,992	250,650	12,964
Pike perch (sauger)								
Rock bass					110,575	3,236	3,700	185
Sturgeon	13,137	565	54,850	3,408	34,047	2,162	8,725	569
Sturgeon caviar			1,570	1,131	296	241	75	60
Suckers, fresh	48,549	724	2,133,776	27,531	2,061,578	48,974	82,900	1,027
Suckers, salted	134,747	2,199	783,765	17,731	628,576	12,886		
Sun-fish					42,482	1,066	6,500	325
Trout, fresh	4,190,742	157,096	8,955,423	426,212	2,086,880	99,386		
Trout, salted	764,088	33,795	93,876	4,219	21,752	738		
Trout, steelhead			169	17				
White bass			400	15				
White-fish, fresh	747,499	33,985	1,850,032	111,403	654,362	40,679	25,591	1,904
White-fish, salted	46,523	1,737	122,212	7,246	38,101	1,327		
White-fish, smoked			350	35				
White-fish caviar					400	46		
White-fish (bluefin), fresh	2,033,522	56,512	631,664	21,562				
White-fish (bluefin), salted	61,782	2,375						
White-fish (bluefin), smoked			3,000	300				
White-fish (longjaw)	290,575	4,810	186,505	7,809	74,400	2,672		
White-fish (Menominee), fresh	13,919	334	119,834	3,368	116,700	3,926		
White-fish (Menominee), salted	1,675	67	144,425	6,384	28,755	1,321		
Yellow perch, fresh	10,165	101	3,292,260	62,910	1,911,002	44,826	4,600	230
Yellow perch, salted			21,128	331				
Crawfish			244,464	7,897				
Total	13,205,013	343,671	33,579,498	1,090,550	14.455,209	450,318	521,941	21,594

Species.	Lake Erie.		Lake Ontario.[c]		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	4,825	$387	28,335	$1,813	38,737	$2,694
Buffalo-fish					2,002	45
Cat-fish and bullheads	181,775	7,471	349,224	12,903	751,833	27,884
Dog-fish or bowfin	1,062	6			17,253	303
Eels			73,595	4,233	75,533	4,347
Fresh-water drum	642,445	4,513	4,300	86	746,021	5,700
German carp	3,546,752	59,198	16,320	432	4,237,643	71,285
Herring, fresh	8,788,625	333,844	105,315	5,170	18,719,323	497,114
Herring, salted			16,000	640	13,434,716	318,062
Herring, smoked					3,290	252
Ling or lawyer, fresh	13,693	99	600	18	133,878	1,628
Ling or lawyer, salted					900	18
Minnows					3,000	800
Muskellunge					3,420	429
Pike and pickerel, fresh			31,359	2,080	298,466	15,668
Pike and pickerel, salted					1,610	30
Pike perch (blue pike)	4,915,357	188,033	66,065	3,353	4,981,422	191,386
Pike perch (wall-eyed)	908,484	49,462	8,025	650	3,076,147	168,284
Pike perch (sauger)	1,940,355	47,697			1,940,355	47,697
Rock bass	1,005	21	22,119	321	137,399	3,763
Sturgeon	294,226	21,586	213,590	11,504	618,575	39,794

[a] Includes St. Clair and Detroit rivers.
[b] The herring catch of Lake Michigan includes chubs.
[c] Includes St. Lawrence and Niagara rivers.

Table showing by lakes and species the yield of the fisheries of the Great Lakes in 1903—Continued.

Species.	Lake Erie.		Lake Ontario.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Sturgeon caviar	5,877	$4,894	12,505	$6,897	20,323	$13,223
Suckers, fresh	721,089	8,695	99,060	1,809	5,146,952	88,760
Suckers, salted					1,547,088	32,816
Sun-fish	1,200	8	34,089	482	84,271	1,881
Trout, fresh	15,127	800	4,050	279	15,252,222	683,773
Trout, salted					879,716	38,752
Trout, steelhead					169	17
White bass	27,651	940	2,000	40	30,051	995
White-fish, fresh	302,805	22,988	25,384	2,122	3,605,673	213,081
White-fish, salted					206,836	10,310
White-fish, smoked					350	35
White-fish caviar					400	46
White-fish (bluefin), fresh					2,665,186	81,074
White-fish (bluefin), salted					61,782	2,375
White-fish (bluefin), smoked					3,000	300
White-fish (longjaw)					551,480	15,291
White-fish (Menominee), fresh					250,453	7,628
White-fish (Menominee), salted					174,855	7,772
Yellow perch, fresh	830,403	27,001	132,165	4,271	6,180,595	139,339
Yellow perch, salted					21,128	331
Crawfish					244,464	7,897
Frogs			500	250	500	250
Turtles	45,800	2,372			45,800	2,372
Total	23,188,556	780,015	1,244,600	59,353	86,194,817	2,745,501

Comparative table showing the number of persons employed in the fisheries of the Great Lakes in 1880, 1885, 1890, 1893, 1899, and 1903.

Lake.	1880.	1885.	1890.	1893.	1899.	1903.
Superior	414	914	653	916	613	918
Michigan	1,578	3,379	2,877	3,928	3,255	3,241
Huron	470	892	726	944	1,241	1,704
St. Clair[a]	356	272	611	529	442	355
Erie	1,620	4,298	4,482	3,622	3,728	2,727
Ontario[b]	612	600	389	241	391	388
Total	5,050	10,355	9,738	10,180	9,670	9,333

[a] Includes St. Clair and Detroit rivers.
[b] Includes St. Lawrence and Niagara rivers.

Comparative table showing the apparatus and capital employed in the fisheries of the Great Lakes in 1880, 1885, 1890, 1893, 1899, and 1903.

Lake and year.	Vessels and boats.		Pound nets and trap nets.		Gill nets.		Seines.		Other apparatus, value.	Shore property and cash capital.	Total investment.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.			
Superior:											
1880	161	$26,240	43	$14,950	4,630	$25,280	32	$2,010	$200	$12,700	$81,380
1885	519	100,735	230	67,520	7,557	78,082	43	2,920	1,155	177,521	427,933
1890	328	85,275	140	34,435	5,974	63,476	19	955	2,763	179,778	366,682
1893	447	139,035	276	63,415	8,899	87,680	14	500	1,565	209,512	529,024
1899	315	69,045	162	25,820	7,229	99,283	1	50	1,058	167,023	372,083
1903	378	141,109	218	27,793	10,169	127,238	8	335	815	299,032	596,322
Michigan:											
1880	836	133,375	476	185,425	24,599	124,740	19	2,040	1,455	104,100	551,135
1885	1,402	308,326	715	253,840	58,516	326,902	87	6,950	13,457	788,356	1,757,831
1890	1,102	266,331	844	244,880	40,896	215,914	30	3,480	13,460	693,159	1,437,224
1893	1,519	357,987	785	181,385	54,232	352,084	28	2,520	27,863	1,092,219	2,063,497
1899	1,178	281,968	805	186,349	49,857	288,395	11	510	29,285	2,087,829	2,915,241
1903	1,363	386,396	980	198,960	48,645	269,754	44	2,384	37,743	2,593,950	3,489,187

Comparative table showing the apparatus and capital employed in the fisheries of the Great Lakes in 1880, 1885, 1890, 1893, 1899, and 1903—Continued.

Lake and year.	Vessels and boats.		Pound nets and trap nets.		Gill nets.		Seines.		Other apparatus, value.	Shore property and cash capital.	Total investment.
	No.	Value.	No.	Value.	No.	Value.	No.	Value.			
Huron:											
1880	111	$20,905	189	$49,425	3,360	$20,600	28	$5,600	$3,500	$3,700	$103,730
1885	561	72,916	586	113,350	3,441	35,335	.....	....	23,100	140,620	385,349
1890	417	36,898	551	88,515	2,206	21,665	6	600	7,155	254,025	408,858
1893	520	87,045	731	108,508	4,923	53,071	1	75	3,807	236,285	503,700
1899	539	87,585	996	111,839	5,676	54,381	9	673	8,188	203,989	474,958
1903	643	126,418	1,685	176,195	6,129	51,526	18	608	13,977	482,615	851,639
St. Clair:											
1880	52	8,600	....	....	180	1,080	42	6,000	1,500	24,000	40,580
1885	215	7,457	57	12,550	23	160	34	8,825	3,819	218,270	251,081
1890	166	28,775	31	9,450	814	9,418	28	6,240	5,580	150,682	210,145
1893	211	13,728	91	7,400	380	4,260	20	3,025	2,346	206,672	240,076
1899	188	3,770	5	1,050	60	600	13	1,255	915	46,945	54,535
1903	150	3,150	....	....	....	....	6	890	961	234,884	239,885
Erie:											
1880	602	83,880	758	233,600	5,775	22,500	18	2,800	8,645	163,675	515,100
1885	1,536	298,757	1,028	259,785	22,644	75,507	71	8,320	72,205	847,564	1,562,138
1890	1,449	520,033	1,893	548,100	49,320	169,513	41	5,305	70,601	1,502,750	2,816,302
1893	1,146	424,227	1,783	439,060	35,369	164,683	47	4,440	23,339	1,423,017	2,506,842
1899	980	435,566	1,724	329,500	41,678	229,182	104	8,390	19,362	1,614,677	2,720,554
1903	608	490,236	1,469	172,805	35,150	180,581	110	8,040	18,350	1,826,385	2,196,397
Ontario:											
1880	167	13,100	34	14,000	6,000	20,000	9	1,950	....	5,000	54,050
1885	467	20,448	350	19,445	4,722	23,952	69	3,177	12,627	56,100	135,749
1890	376	31,162	288	24,577	2,345	18,110	27	656	10,361	38,667	123,533
1893	177	9,619	77	2,310	1,185	8,794	7	175	2,240	32,250	56,131
1899	289	9,482	115	5,850	1,187	18,671	24	420	7,191	38,640	80,350
1903	231	15,457	176	9,945	1,796	13,862	8	205	9,303	52,220	100,992
All lakes:											
1880	1,929	285,500	1,500	497,400	41,514	214,200	148	20,400	15,300	313,175	1,315,975
1885	4,700	868,669	2,966	726,490	96,906	539,936	304	30,192	126,368	2,228,431	4,520,081
1890	3,838	968,471	3,750	919,957	101,555	498,096	154	17,236	109,920	2,819,061	5,362,774
1893	4,050	1,032,241	3,743	802,078	104,988	670,572	117	10,735	61,160	3,199,955	5,899,270
1899	3,489	887,416	3,837	660,408	105,687	690,518	162	11,298	66,002	4,159,103	6,617,716
1903	3,376	1,162,766	4,528	585,998	101,889	642,961	191	12,462	81,149	4,989,086	7,474,422

Table showing the products of the fisheries of the Great Lakes in 1880, 1885, 1890, 1893, 1899, and 1903.

Lake and year.	White-fish.	Trout.	Herring.	Sturgeon.	All others.	Total.	
	Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Value.*
Superior:							
1880	2,257,000	1,464,750	31,000	....	60,875	3,816,625	$118,370
1885	4,571,947	3,488,177	321,680	182,760	258,416	8,825,980	291,523
1890	3,213,176	2,613,378	199,121	47,482	42,835	6,115,992	220,968
1893	2,732,270	4,342,122	660,272	62,052	300,211	8,096,927	252,107
1899	693,191	3,118,169	1,125,478	4,415	488,401	5,429,654	150,862
1903	794,022	4,954,830	4,742,805	13,137	2,700,219	13,205,013	343,671
Michigan:							
1880	12,030,400	2,659,450	3,050,400	3,839,600	1,562,025	23,141,875	668,400
1885	8,682,986	6,431,298	3,312,493	1,406,678	3,684,693	23,518,148	878,788
1890	5,455,079	8,364,167	6,082,082	946,897	5,586,041	26,434,266	830,465
1893	2,330,060	8,216,920	11,580,895	311,780	8,308,100	30,747,755	828,611
1899	1,510,364	5,488,947	21,573,716	108,279	5,818,690	34,499,996	876,743
1903	1,972,594	9,049,299	13,863,617	56,420	8,637,568	33,579,498	1,090,550
Huron:							
1880	2,700,778	2,084,500	246,800	204,000	1,969,195	7,205,273	195,277
1885	1,425,380	2,539,780	1,265,650	215,500	6,010,860	11,457,170	276,397
1890	1,004,094	1,505,619	2,514,551	365,718	4,666,399	10,056,381	221,067
1893	1,178,271	3,439,575	2,758,628	79,553	4,608,311	12,064,338	306,881
1899	592,308	1,887,101	3,699,807	30,497	6,208,614	12,418,327	308,078
1903	692,863	2,108,632	4,640,967	34,343	6,978,404	14,455,209	450,318
St. Clair:							
1880	77,922	....	250,700	998,500	523,805	1,850,927	36,273
1885	41,125	....	1,208,150	227,780	708,740	2,185,795	40,193
1890	238,764	244,847	490,334	309,008	1,711,623	2,994,571	73,577
1893	50,950	72,000	140,112	54,106	1,497,143	1,814,311	46,030
1899	69,902	69,915	....	7,600	431,650	579,067	23,864
1903	25,591	....	....	8,800	487,550	521,941	21,594
Erie:							
1880	3,333,800	26,200	11,774,400	1,970,000	11,982,900	29,087,300	474,880
1885	3,531,855	106,900	19,354,900	4,727,950	23,734,912	51,456,517	1,109,096
1890	2,341,451	121,420	38,868,283	2,078,907	21,440,812	64,850,873	1,000,905
1893	1,292,410	203,132	20,931,076	793,800	19,747,907	42,968,325	805,979
1899	2,066,314	32,024	33,427,797	789,402	22,078,327	58,393,864	1,150,895
1903	302,805	15,127	8,788,625	300,103	13,781,896	23,188,556	780,015

Table showing the products of the fisheries of the Great Lakes in 1880, 1885, 1890, 1893, 1899, and 1903—Continued.

Lake and year.	White-fish.	Trout.	Herring.	Sturgeon.	All others.	Total.	
	Pounds	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Value.*
Ontario:							
1880........	1,064,000	569,700	611,217	545,283	849,800	3,640,000	$159,760
1885........	90,711	20,510	403,585	386,974	1,496,686	2,398,466	95,869
1890........	148,771	41,010	598,978	541,752	2,115,937	3,446,448	124,786
1893........	45,380	6,204	164,998	125,293	586,140	928,015	31,510
1899........	161,935	15,432	86,778	189,155	1,953,032	2,406,332	100,997
1903........	25,384	4,050	121,315	226,095	867,756	1,214,600	59,353
All lakes:							
1880........	21,463,900	6,804,600	15,967,517	7,557,383	16,948,600	68,742,000	1,652,900
1885........	18,344,004	12,586,665	25,869,458	7,147,642	35,894,307	99,842,076	2,691,866
1890........	12,401,335	12,890,441	48,753,349	4,289,759	35,563,647	113,898,531	2,471,768
1893........	7,629,341	16,279,953	36,235,981	1,426,584	35,047,812	96,619,671	2,270,618
1899........	5,094,014	10,611,588	59,913,576	1,129,348	36,978,714	113,727,240	2,611,439
1903........	3,813,259	16,131,938	32,157,319	638,898	33,453,393	86,194,817	2,745,501

NOTE.—In the above table caviar and other secondary products are omitted except for 1893, 1899, and 1903. In 1880, 1885, and 1890 bluefins, longjaws, and Menominees in Lake Michigan and Menominees in Lake Huron are included with white-fish. In 1893 and 1899 bluefins in Lake Superior, bluefins and Menominees in Lake Michigan, and Menominees in Lake Huron are included with "all others," and longjaws in Lake Michigan with herring. In 1903 bluefins, Menominees, longjaws, and steelhead trout are included with "all other."

FISHERIES OF LAKE SUPERIOR.

The fishing season on Lake Superior is governed largely by weather conditions, and therefore varies considerably in length in different years. The fishing begins in the spring as soon as the lake is sufficiently free from ice, and continues until ice forms again in the fall. In 1903 the season opened in some localities as early as March 15, and at Isle Royale about April 15, and was regarded by the dealers as the most satisfactory season in the past ten years.

The number of persons employed in the fisheries of Lake Superior in 1903 was 918, of whom 175 were on vessels fishing and transporting, 613 on boats in the shore fisheries, and 130 were engaged as shoresmen in the wholesale fishery trade and other occupations on shore connected with the fisheries.

The investment in the fisheries of this lake was $596,322, and included 21 fishing and transporting vessels, of 639 net tons, valued at $75,700, and their outfits, at $23,731; 357 boats and gasoline launches, valued at $41,678; fishing apparatus used on vessels and boats to the value of $156,181; shore and accessory property valued at $156,332, and cash capital amounting to $142,700. The principal forms of fishing apparatus were gill nets, pound nets, and trap nets. The number of gill nets used on vessels was 4,455, valued at $63,538, and on boats, 5,714, valued at $63,700, a total of 10,169, valued at $127,238. The number of pound nets and trap nets operated was 218, valued at $27,793. Seines, fyke nets, dip nets, lines, and spears were also used to some extent. Gasoline boats were introduced in the fisheries of this lake in 1899 and are growing in favor with the fishermen. The number employed in 1903 was 35, valued at $21,150.

The products of the fisheries aggregated 13,205,013 pounds, for which the fishermen received $343,671. The principal species taken

were herring, 4,742,805 pounds, valued at $45,684; lake trout, 4,954,830 pounds, valued at $190,891; white-fish, 794,022 pounds, valued at $35,722; bluefin white-fish, 2,095,304 pounds, valued at $58,887, and longjaw white-fish, 290,575 pounds, valued at $4,810.

Compared with the returns for 1899 there has been an increase of 305, or nearly 50 per cent, in the number of persons employed, $224,239, or about 60 per cent, in the amount of capital invested, and 7,775,359 pounds, or 143 per cent, in the quantity, and $192,809, or nearly 128 per cent, in the value of the products. The increase in products consisted chiefly of herring, 3,617,327 pounds, $33,914; white-fish, 100,831 pounds, $10,175; bluefin white-fish, 1,660,244 pounds, $47,570; longjaw white-fish, 290,575 pounds, $4,810; lake trout, 1,836,661 pounds, $90,192; wall-eyed pike, 80,212 pounds, $2,956, and suckers, 171,649 pounds, $2,752. The proportion of increase was very large in the catch of both herring and bluefin white-fish, the former being four times and the latter five times as great as in 1899. The herring were mostly taken in gill nets around the Apostle Islands and along the north shore. They were in good demand at St. Paul, Minneapolis, Chicago, and among the farmers in Wisconsin, North Dakota, South Dakota, and Montana. The bluefin white-fish were also caught chiefly in gill nets and were in good demand. The greater part of the catch of this species is sold fresh by the fishermen, but considerable quantities are smoked by dealers in St. Paul and other cities.

The fisheries of this lake are conducted from the various localities along the shore, the Apostle Islands, and Isle Royale. The steamers at Sault Ste. Marie fish chiefly at Iroquois Point and Whitefish Bay, and those at Grand Marais cover a distance of about 30 miles east and 35 miles west of their home port. The steamers at Marquette fish to the northwest as far as Keweenaw Point, a distance of 60 miles, and to the eastward from the home port about 40 miles. At Ontonagon the steamers fish about 25 miles east and west of their home port and from 28 to 30 miles from shore, setting their gill nets till about the 1st of November in from 65 to 90 fathoms of water. During November the nets are set in 100 to 120 fathoms, the catch at that time being chiefly siscowet trout. White-fish are mostly taken in April, May, and the early part of June in gill nets set in from 16 to 30 fathoms of water.

Near Sault Ste. Marie, at the outlet of Lake Superior, 98 trap nets, valued at $2,450, and 25 fyke nets, valued at $250, were fished in St. Mary's River for some 20 miles between Sault Ste. Marie and Sailors Encampment. The catch consisted of wall-eyed pike, 32,572 pounds, $827; pickerel, 10,792 pounds, $215; yellow perch, 10,165 pounds, $101; catfish and bullheads, 588 pounds, $18, and sturgeon, 79 pounds, $4. These fish are credited to Lake Superior, and are included with the statistics for Chippewa County, Mich.

The Apostle Islands are a group of about 20 islands, 18 of which are in Ashland County and 2 in Bayfield County, Wis. The three large fishing firms at Bayfield, engaged in fishing with steamers and buying fish of the boat fishermen, have fishing camps on Stockton Island or Presque Isle. Other islands also have camps of boat fishermen. Fishing is carried on around the islands from the breaking up of the ice in the spring until it forms again in the fall, a period of about six or seven months, the length of time varying with the seasons. Most of the fishermen live at Bayfield, and spend the winter at home or at work in the lumber camps. The fishing about the islands is prosecuted with pound nets, haul seines, and gill nets. The pound nets have a leader from 5 to 40 rods long with meshes of 5 to 6 inches, and a pot or pound from 24 to 28 feet square with meshes of 3½ inches stretched. The pound nets are set in from 10 to 45 feet of water. In 1903 56 pound nets were fished around the Apostle Islands, including Long Island. Of these, 41 were in Ashland County and 15 in Bayfield County, Wis. There were 8 haul seines with meshes of 2½ to 3 inches. These were owned at Bayfield and were fished at various islands, their location being changed from one island to another as occasion required. Gill nets were used by steamers and small boats, and were to some extent fished under the ice during the winter.

Isle Royale is in the northwestern part of the lake in Keweenaw County, Mich. The fishing grounds of this section are located about this island and the numerous smaller islands in its vicinity, and from 10 to 20 miles from the main shore. The fishing season opens as soon as the water is free from ice, and practically closes October 30. In 1903 fishing began about the middle of April and in 1904 a month later. The laws of Michigan provide for a close season from October 30 to December 15.

Gill nets are the principal form of apparatus employed. Pound nets and also hooks and lines are used to a limited extent. The size of mesh used in gill nets is 4½ inch for white-fish, 3½ inch for bluefin white-fish, and 2⅝ inch for herring. Gill nets for trout and white-fish are fished by being anchored on the bottom in from 75 to 125 fathoms of water, the best catches being made in May and June. After August 15 the fall catch is taken with gill nets having a 5½ to 6 inch mesh, nearly all the fall catch being lake trout averaging from 6 to 7 pounds each when dressed. These are caught in from 6 to 30 fathoms of water and shipped fresh. The gill nets are chiefly made of No. 35 imported flax thread, 3 pounds being used for a net of 65 leads. Deep-water gill nets with 5½-inch mesh are made of No. 40 cotton twine. In shallow water the fish are more active and the water is rougher, and therefore stronger nets are required than in deep water.

In the line fisheries set lines are used to some extent until about July 15. These have 50 hooks each, the gangings with one hook each being

attached to the main line about 8 to 10 feet apart. A number of these short lines are fastened together, forming one long line of 500 to 1,000 hooks. These are anchored at distances of every 50 hooks and buoyed from 5 to 20 feet below the surface in from 75 to 100 fathoms of water. Set lines are never used near the shore or in shallow water. Troll lines with spoon hooks are employed from June 15 to August 1, the fish at that time being near the shore.

During the fishing season the fishermen and their families camp on several of the numerous islands near the fishing grounds. Their fishing boats, except 3 gasoline launches, are small, strongly built sailboats. The islands are not connected by cable with the mainland, the only communication being by steamers and small boats. There are no stores or post-offices. The mail is carried by steamers and delivered at the various fishing camps. A number of fishing clubs have camps on the islands. Washington Harbor, at the southwest end of Isle Royale, is a rendezvous for fishermen and summer campers. The log houses of the fishermen and two hotels, one of which has several cottages connected with it, form quite an attractive settlement during the fishing season. In this section trout constitute the greater part of the catch, white-fish being taken only occasionally in the fishing near shore. A ton of fish caught in this vicinity usually consists of about 1,500 pounds of siscowet trout and 500 pounds of lake trout and bluefin white-fish. In August there is not much fishing by the shore fishermen, the fish being farther out in the lake than the fishermen care to venture in their small boats. From the last of August to the first of October the fish are near the island, and are then taken in gill nets in from 1 to 30 fathoms of water. They will not notice the trolling hooks at this time in the season. At the end of October the fishermen with their families remove to their permanent homes, which are mostly at Duluth. They usually spend the winter in preparing their fishing apparatus for the next season, or at work in the mines and lumber camps. After the fishing season closes no regular steamers visit the islands, and they are deserted by all except a few watchmen who remain to care for the hotels and property left by the fishermen.

The following tables give, by states and counties, the extent of the fisheries of Lake Superior in 1903:

Table showing by states and counties the number of persons employed in the fisheries of Lake Superior in 1903.

State and county.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
Michigan:					
Alger	16	....	31	23	70
Baraga	....	....	8	....	8
Chippewa	11	....	60	20	91
Houghton	....	....	47	....	47
Keweenaw	....	....	105	....	105
Marquette	23	....	17	17	57
Ontonagon	16	....	10	12	38
Total	66	....	278	72	416
Wisconsin:					
Ashland	10	....	83	7	100
Bayfield	86	6	65	20	177
Iron	....	....	2	....	2
Total	96	6	150	27	279
Minnesota:					
Cook	....	....	69	....	69
Lake	....	....	99	....	99
St. Louis	7	....	17	31	55
Total	7	....	185	31	223
Grand total	169	6	613	130	918

Table showing by states and counties the apparatus and capital employed in the fisheries of Lake Superior in 1903.

State and county.	Vessels fishing.				Vessels transporting.				Boats.		Gasoline launches.	
	No.	Tonnage.	Value.	Value of outfit.	No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.
Michigan:												
Alger	2	120	$15,500	$2,300	....	......	......	......	2	$130	9	$7,250
Baraga	....	......	......	......	....	......	......	......	6	225	....	......
Chippewa	2	57	7,600	1,300	....	......	......	......	36	1,865	....	......
Houghton	....	......	......	......	....	......	......	......	40	2,000	4	2,500
Keweenaw	....	......	......	......	....	......	......	......	50	4,065	7	3,550
Marquette	3	63	8,500	6,665	....	......	......	......	11	675	2	700
Ontonagon	2	53	5,000	3,100	....	......	......	......	1	25	3	1,300
Total	9	293	36,600	13,365	....	......	......	......	116	8,985	25	15,300
Wisconsin:												
Ashland	1	9	1,000	200	....	......	......	......	54	2,810	2	800
Bayfield	9	192	29,600	8,997	1	131	$7,000	$1,094	26	1,548	3	3,000
Iron	....	......	......	......	....	......	......	......	....	......	1	350
Total	10	201	30,600	9,197	1	131	7,000	1,094	80	4,358	6	4,150
Minnesota:												
Cook	....	......	......	......	....	......	......	......	34	2,565	3	1,400
Lake	....	......	......	......	....	......	......	......	50	3,695	1	300
St. Louis	1	14	1,500	75	....	......	......	......	12	925	....	......
Total	1	14	1,500	75	....	......	......	......	96	7,185	4	1,700
Grand total	20	508	68,700	22,637	1	131	7,000	1,094	322	20,528	35	21,150

Table showing by states and counties the apparatus and capital employed in the fisheries of Lake Superior in 1903—Continued.

State and county.	Apparatus of capture—vessel fisheries.		Apparatus of capture—shore fisheries.					
	Gill nets.		Pound nets and trap nets.		Gill nets.		Fyke nets.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Michigan:								
Alger	560	$12,880	....	....	620	$6,747	....	....
Baraga	....	....	6	$1,200	7	42	....	....
Chippewa	360	7,880	113	7,942	48	300	25	$250
Houghton	....	....	3	600	987	7,149	....	....
Keweenaw	....	....	26	6,625	815	12,775	....	....
Marquette	1,304	16,308	1	200	450	4,200	....	....
Ontonagon	830	8,836	9	1,100	173	1,945	....	....
Total	3,054	45,904	158	17,667	3,100	33,158	25	250
Wisconsin:								
Ashland	25	375	41	7,326	774	7,432	....	....
Bayfield	1,360	16,971	15	2,400	439	4,810	....	....
Iron	....	....	....	....	25	250	....	....
Total	1,385	17,346	56	9,726	1,238	12,492	....	....
Minnesota:								
Cook	....	....	4	400	576	7,905	....	....
Lake	....	....	....	....	700	8,645	....	....
St. Louis	16	288	....	....	100	1,500	....	....
Total	16	288	4	400	1,376	18,050	....	....
Grand total	4,455	63,538	218	27,793	5,714	63,700	25	250

State and county.	Apparatus of capture—shore fisheries.					Shore and accessory property.	Cash capital.	Total investment.
	Dip nets and spears.		Seines.		Set lines and hand lines.			
	No.	Value.	No.	Value.	Value.			
Michigan:								
Alger	......	....	......	....	....	$8,275	$32,000	$85,082
Baraga	......	....	......	....	....	370	....	1,837
Chippewa	43	$268	......	....	....	40,833	30,000	98,238
Houghton	......	....	......	....	....	2,875	....	15,124
Keweenaw	......	....	......	....	$66	4,475	....	31,556
Marquette	......	....	......	....	....	7,360	14,500	59,108
Ontonagon	......	....	......	....	....	7,380	8,000	36,686
Total	43	268	......	....	66	71,568	84,500	327,631
Wisconsin:								
Ashland	......	....	8	$335	98	15,216	10,000	45,592
Bayfield	......	....	......	....	23	27,100	23,500	126,043
Iron	......	....	......	....	....	50	....	650
Total	......	....	8	335	121	42,366	33,500	172,285
Minnesota:								
Cook	......	....	......	....	110	2,895	....	15,275
Lake	......	....	......	....	....	2,400	....	15,010
St. Louis	......	....	......	....	....	37,103	24,700	66,091
Total	......	....	......	....	110	42,398	24,700	96,406
Grand total	43	268	8	335	297	156,332	142,700	596,322

Table showing by states, counties, and species the yield of the fisheries of Lake Superior in 1903.

State and county.	Cat-fish and bullheads.		Herring, fresh.		Herring, salted.		Pike and pickerel.		Pike perch (wall-eyed).	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Baraga	...	...	4,000	$120	...	...	...	...	...	...
Chippewa	588	$18	52,320	1,510	...	...	10,792	$215	28,883	$909
Houghton	...	...	47,130	942	...	...	...	...	...	...
Keweenaw	...	...	105,161	1,357	143,213	$3,172	...	...	...	...
Ontonagon	...	...	...	...	...	...	...	...	244	14
Total	588	18	208,611	3,929	143,213	3,172	10,792	215	29,127	923
Wisconsin:										
Ashland	...	...	263,170	1,753	29,641	437	74	3	63,812	2,492
Bayfield	...	...	2,738,812	16,321	14,402	359	...	...	838	34
Iron	...	...	...	...	...	...	...	...	54	2
Total	...	...	3,001,982	18,074	44,043	796	74	3	64,704	2,528
Minnesota:										
Cook	...	...	296,897	4,499	113,232	2,420	...	...	...	...
Lake	...	...	593,432	7,520	134,895	2,730	...	...	...	...
St. Louis	...	...	206,500	2,544	...	...	...	...	...	...
Total	...	...	1,096,829	14,563	248,127	5,150	...	...	...	...
Grand total	588	18	4,307,422	36,566	435,383	9,118	10,866	218	93,831	3,451

State and county.	Sturgeon.		Suckers, fresh.		Suckers, salted.		Trout, fresh.		Trout, salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Alger	...	...	...	...	...	...	838,434	$31,793	115,500	$4,979
Baraga	...	...	...	...	...	...	5,880	333	...	...
Chippewa	1,215	$68	23,150	$463	...	...	337,584	12,920	20,600	876
Houghton	520	32	...	...	...	...	232,950	9,706	45,000	3,150
Keweenaw	...	...	...	...	1,400	$40	434,350	15,319	266,661	11,632
Marquette	...	...	...	...	...	...	829,145	30,686	37,500	1,650
Ontonagon	871	60	...	...	...	...	252,688	10,172	1,900	67
Total	2,606	160	23,150	463	1,400	40	2,931,031	110,929	487,161	22,354
Wisconsin:										
Ashland	10,447	401	23,059	241	97,162	1,555	478,569	17,890	15,310	514
Bayfield	84	4	2,340	20	35,985	601	497,329	19,401	52,018	1,601
Iron	...	...	...	...	200	3	3,367	126	1,270	45
Total	10,531	405	25,399	261	133,347	2,159	979,265	37,417	68,598	2,160
Minnesota:										
Cook	...	...	...	...	...	...	211,782	7,181	67,429	2,942
Lake	...	...	...	...	...	...	59,064	1,194	140,900	6,339
St. Louis	...	...	...	...	...	...	9,600	375	...	...
Total	...	...	...	...	...	...	280,446	8,750	208,329	9,281
Grand total	13,137	565	48,549	724	134,747	2,199	4,190,742	157,096	764,088	33,795

Table showing by states, counties, and species the yield of the fisheries of Lake Superior in 1903—Continued.

State and county.	White-fish, fresh.		White-fish, salted.		White-fish (bluefin), fresh.		White-fish (bluefin), salted.		White-fish (longjaw).	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Alger	88,165	$3,976			455,786	$13,296	2,500	$106		
Baraga	12,600	750								
Chippewa	313,210	14,066			107,233	3,128				
Houghton	78,312	3,263	3,000	$210	18,120	755				
Keweenaw	35,268	1,455	5,700	209	92,847	2,057	30,923	1,203	11,967	$199
Marquette	50,780	2,276			523,712	15,392				
Ontonagon	70,212	3,944			491,971	13,324				
Total	648,547	29,730	8,700	419	1,689,669	47,952	33,423	1,309	11,967	199
Wisconsin:										
Ashland	65,588	2,834	16,891	639	22,693	844	5,549	180	42,804	654
Bayfield	32,720	1,389	13,678	448	157,561	3,997	2,257	67	100,773	1,702
Iron	31	1								
Total	98,339	4,224	30,569	1,087	180,254	4,841	7,806	217	143,577	2,356
Minnesota:										
Cook	613	31	5,379	171	113,139	2,477	20,553	819	7,263	126
Lake			1,875	60	40,414	991			98,560	1,642
St. Louis					10,046	251			29,208	487
Total	613	31	7,254	231	163,599	3,719	20,553	819	135,031	2,255
Grand total	747,499	33,985	46,523	1,737	2,033,522	56,512	61,782	2,375	290,575	4,810

State and county.	White-fish (Menominee), fresh.		White-fish (Menominee), salted.		Yellow perch.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:								
Alger							1,500,385	$54,150
Baraga							22,480	1,203
Chippewa					10,165	$101	905,740	34,274
Houghton							425,032	18,058
Keweenaw	223	$7					1,127,713	36,650
Marquette							1,441,137	50,004
Ontonagon							817,886	27,581
Total	223	7			10,165	101	6,240,373	221,920
Wisconsin:								
Ashland							1,134,769	30,437
Bayfield							3,648,797	45,944
Iron							4,922	177
Total							4,788,488	76,558
Minnesota:								
Cook	13,696	327					849,983	20,993
Lake			1,675	$67			1,070,815	20,543
St. Louis							255,354	3,657
Total	13,696	327	1,675	67			2,176,152	45,193
Grand total	13,919	334	1,675	67	10,165	101	13,205,013	343,671

Table showing by states, counties, and species the yield of vessel gill-net fisheries of Lake Superior in 1903.

State and county.	Herring.		Pike perch (wall-eyed pike).		Suckers, salted.		Trout, fresh.		Trout, salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Alger							593,717	$22,265	72,500	$3,124
Chippewa							309,561	11,869	20,600	876
Marquette							700,265	25,733	22,500	975
Ontonagon							188,566	7,657	1,000	35
Total							1,792,109	67,524	116,600	5,010
Wisconsin:										
Ashland	204,655	$1,239								
Bayfield	2,501,324	14,823	222	$9	800	$16	300,799	11,820	50,045	1,535
Total	2,705,979	16,062	222	9	800	16	300,799	11,820	50,045	1,535
Minnesota:										
St. Louis	112,000	1,400								
Grand total	2,817,979	17,462	222	9	800	16	2,092,908	79,314	166,645	6,515

State and county.	White-fish.		White-fish (bluefin), fresh.		White-fish (bluefin), salted.		White-fish (longjaw).		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Alger	21,688	$872	319,404	$9,316	2,500	$106			1,009,809	$35,683
Chippewa	88,703	3,993	107,233	3,128					526,097	19,866
Marquette	22,020	1,036	523,712	15,392					1,268,497	43,136
Ontonagon	8,899	519	429,571	11,634					628,036	19,845
Total	141,310	6,420	1,379,920	39,470	2,500	106			3,432,439	118,530
Wisconsin:										
Ashland									204,655	1,239
Bayfield	405	17	117,607	3,003	1,300	42	73,584	$1,226	3,046,086	32,491
Total	405	17	117,607	3,003	1,300	42	73,584	1,226	3,250,741	33,730
Minnesota:										
St. Louis									112,000	1,400
Grand total	141,715	6,437	1,497,527	42,473	3,800	148	73,584	1,226	6,795,180	153,660

Table showing by states, counties, species, and apparatus of capture the yield of the shore fisheries of Lake Superior in 1903.

Apparatus and species.	Michigan.							
	Alger.		Baraga.		Chippewa.		Houghton.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:								
Pike and pickerel					9,713	$194		
Pike perch (wall-eyed)					25,626	819		
Sturgeon					1,215	68		
Trout, fresh			5,880	$333	28,023	1,051	18,000	$750
White-fish, fresh			12,600	750	219,507	9,823	10,800	450
Yellow perch					9,149	91		
Total			18,480	1,083	293,233	12,046	28,800	1,200
Gill nets:								
Herring, fresh			4,000	120	40,320	1,210	47,130	942
Sturgeon							520	32
Trout, fresh	244,717	$9,528					214,950	8,956
Trout, salted	43,000	1,855					45,000	3,150
White-fish, fresh	66,477	3,104					67,512	2,813
White-fish, salted							3,000	210
White-fish (bluefin), fresh	136,382	3,980					18,120	755
Total	490,576	18,467	4,000	120	40,320	1,210	396,232	16,858

Table showing by states, counties, species, and apparatus of capture the yield of the shore fisheries of Lake Superior in 1903—Continued.

Apparatus and species.	Michigan.							
	Alger.		Baraga.		Chippewa.		Houghton.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fyke nets:								
Cat-fish and bullheads					588	$0.18		
Pike and pickerel					1,079	21		
Pike perch (wall-eyed)					3,257	90		
Yellow perch					1,016	10		
Total					5,940	139		
Dip nets and spears:								
Herring					12,000	300		
Suckers, fresh					3,000	60		
Suckers, salted					20,150	403		
White-fish					5,000	250		
Total					40,150	1,013		
Grand total	490,576	$18,467	22,480	$1,203	379,643	14,408	425,032	$18,058

Apparatus and species.	Michigan.							
	Keweenaw.		Marquette.		Ontonagon.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:								
Pike and pickerel							9,713	$194
Pike perch (wall-eyed)					244	$14	25,870	833
Sturgeon					871	60	2,086	128
Suckers, salted	1,400	$40					1,400	40
Trout, fresh	118,752	4,392			3,722	155	174,377	6,681
Trout, salted	58,600	2,344			900	32	59,500	2,376
White-fish, fresh	24,350	1,027	14,400	$600	18,113	905	299,770	13,555
White-fish, salted	3,600	144					3,600	144
Yellow perch							9,149	91
Total	206,702	7,947	14,400	600	23,850	1,166	585,465	24,042
Gill nets:								
Herring, fresh	105,161	1,357					193,611	3,629
Herring, salted	143,218	3,172					143,213	3,172
Sturgeon							520	32
Trout, fresh	285,298	9,917	128,880	4,953	60,400	2,360	931,245	35,714
Trout, salted	208,061	9,288	15,000	675			311,061	14,968
White-fish, fresh	10,918	428	14,360	610	43,200	2,520	202,467	9,505
White-fish, salted	2,100	65					5,100	275
White-fish (bluefin), fresh	92,847	2,057			62,400	1,690	309,749	8,482
White-fish (bluefin), salted	30,923	1,203					30,923	1,203
White-fish (longjaw)	11,967	199					11,967	199
White-fish (Menominee), fresh	223	7					223	7
Total	890,711	27,693	158,240	6,268	166,000	6,570	2,146,079	77,186
Fyke nets:								
Cat-fish and bullheads							588	18
Pike and pickerel							1,079	21
Pike perch (wall-eyed)							3,257	90
Yellow perch							1,016	10
Total							5,940	139
Dip nets and spears:								
Herring							12,000	300
Suckers, fresh							3,000	60
Suckers, salted							20,150	403
White-fish							5,000	250
Total							40,150	1,013
Lines:								
Trout	30,300	1,010					30,300	1,010
Grand total	1,127,713	36,650	172,640	6,868	189,850	7,736	2,807,934	103,390

Table showing by states, counties, species, and apparatus of capture the yield of the shore fisheries of Lake Superior in 1903—Continued.

Apparatus and species.	Wisconsin.							
	Ashland.		Bayfield.		Iron.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets and trap nets:								
Herring, fresh	5,202	$52	152	$3			5,354	$55
Herring, salted	6,111	77	9,497	267			15,608	344
Pike perch (wall-eyed)	57,751	2,210	472	20			58,223	2,230
Sturgeon	9,456	359	47	2			9,503	361
Suckers, fresh	4,530	49					4,530	49
Suckers, salted	54,290	870	19,710	330			74,000	1,200
Trout, fresh	106,937	4,142	23,258	957			130,195	5,099
Trout, salted	65	2	113	4			178	6
White-fish, fresh	41,768	1,727	9,501	366			51,269	2,093
White-fish, salted	9,030	275	4,345	133			13,375	408
White-fish (bluefin), fresh	1,886	48	120	2			2,006	50
White-fish (bluefin), salted	560	16	120	5			680	21
White-fish (longjaw)	20,427	280					20,427	280
Total	318,013	10,107	67.335	2,089			385,348	12,196
Gill nets:								
Herring, fresh	53,313	462	237,336	1,495			290,649	1,957
Herring, salted	21,735	330	4,905	92			26,640	422
Pike and pickerel	74	3					74	3
Pike perch (wall-eyed)	6,007	279	144	5	54	$2	6,205	286
Sturgeon	991	42	37	2			1,028	44
Suckers, fresh	7,449	70	2,340	20			9,789	90
Suckers, salted	24,219	362	15,475	255	200	3	39,894	620
Trout, fresh	361,470	13,261	166,719	6,188	3,367	126	531,556	19,575
Trout, salted	15,245	512	1,860	62	1,270	45	18,375	619
White-fish, fresh	19,653	930	22,814	1,006	31	1	42,498	1,937
White-fish, salted	4,781	225	9,333	315			14,114	540
White-fish (bluefin), fresh	20,807	796	39,834	992			60,641	1,788
White-fish (bluefin), salted	4,989	164	837	20			5,826	184
White-fish (longjaw)	22,377	374	27,189	476			49,566	850
Total	563,110	17,810	528,823	10,928	4,922	177	1,096,855	28,915
Seines:								
Herring, salted	1,795	30					1,795	30
Pike perch (wall-eyed)	54	3					54	3
Suckers, fresh	11,080	122					11,080	122
Suckers, salted	18,653	323					18,653	323
Trout	969	135					969	135
White-fish, fresh	4,167	177					4,167	177
White-fish, salted	3,080	139					3,080	139
Total	39,798	929					39,798	929
Lines:								
Trout	9,193	352	6,553	436			15,746	788
Grand total	930,114	29,198	602,711	13,453	4,922	177	1,537,747	42,828

Apparatus and species.	Minnesota.								Grand total.	
	Cook.		Lake.		St. Louis.		Total.			
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Pound nets and trap nets:										
Herring, fresh									5,354	$55
Herring, salted	6,340	$143					6,340	$143	21,948	487
Pike and pickerel									9,713	194
Pike perch (wall-eyed)									84,093	3,063
Sturgeon									11,589	489
Suckers, fresh									4,530	49
Suckers, salted									75,400	1,240
Trout, fresh	47,021	1,551					47,021	1,551	351,593	13,331
Trout, salted	290	12					290	12	59,968	2,394
White-fish, fresh	613	31					613	31	351,652	15,679
White-fish, salted									16,975	552
White-fish (bluefin), fresh	16,532	350					16,532	350	18,538	400
White-fish (bluefin), salted									680	21
White-fish (longjaw)									20,427	280
White-fish (Menominee)	8,203	199					8,203	199	8,203	·199
Yellow perch									9,149	91
Total	78,999	2,286					78,999	2,286	1,049,812	38,524

Table showing by states, counties, species, and apparatus of capture the yield of the shore fisheries of Lake Superior in 1903—Continued.

Apparatus and species.	Minnesota.								Grand total.	
	Cook.		Lake.		St. Louis.		Total.			
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Gill nets:										
Herring, fresh	296,897	$4,499	593,432	$7,520	94,500	$1,144	984,829	$13,163	1,472,089	$18,749
Herring, salted	106,892	2,277	134,895	2,730			241,787	5,007	411,640	8,601
Pike and pickerel									74	3
Pike perch (wall-eyed)									6,205	286
Sturgeon									1,548	76
Suckers, fresh									9,789	90
Suckers, salted									39,894	620
Trout, fresh	140,761	4,830	59,064	1,194	9,600	375	209,425	6,399	1,675,226	61,688
Trout, salted	67,139	2,930	140,900	6,339			208,039	9,269	537,475	24,856
White-fish, fresh									244,965	11,442
White-fish, salted	5,379	171	1,875	60			7,254	231	26,468	1,046
White-fish (bluefin), fresh	96,607	2,127	40,414	991	10,046	251	147,067	3,369	517,457	13,639
White-fish (bluefin), salted	20,553	819					20,553	819	57,302	2,206
White-fish (longjaw)	7,263	126	98,560	1,642	29,208	487	135,031	2,255	196,564	3,304
White-fish (Menominee), fresh	5,493	128					5,493	128	5,716	135
White-fish (Menominee), salted			1,675	67			1,675	67	1,675	67
Total	746,984	17,907	1,070,815	20,543	143,354	2,257	1,961,153	40,707	5,204,087	146,808
Seines:										
Herring, salted									1,79[illegible]	30
Pike perch (wall-eyed)									54	3
Suckers, fresh									11,080	122
Suckers, salted									18,653	323
Trout									969	135
White-fish, fresh									4,167	177
White-fish, salted									3,080	139
Total									39,798	929
Fyke nets:										
Cat-fish and bullheads									588	18
Pike and pickerel									1,079	21
Pike perch (wall-eyed)									3,257	90
Yellow perch									1,016	10
Total									5,940	139
Dip nets and spears:										
Herring									12,000	300
Suckers, fresh									3,000	60
Suckers, salted									20,150	403
White-fish									5,000	250
Total									40,150	1,013
Lines:										
Trout	24,000	800					24,000	800	70,046	2,598
Grand total	849,983	20,993	1,070,815	20,543	143,354	2,257	2,064,152	43,793	6,409,833	190,011

WHOLESALE FISHERY TRADE.

The wholesale fishery trade of Lake Superior in 1903 was conducted by 16 establishments, 1 at Sault Ste. Marie, 2 at Grand Marais, 3 at Marquette, and 2 at Ontonagon, Mich.; 1 at Ashland and 3 at Bayfield, Wis.; and 4 at Duluth, Minn.

The number of persons engaged was 99, the amount of wages paid was $58,580, the value of shore and accesssory property was $106,414, and the cash capital utilized amounted to $142,700. The products, including fresh, salted, and smoked fish, aggregated 12,880,821 pounds, valued at $511,171.

Compared with the returns for 1899 there has been an increase of 10 establishments, 49 employees, $29,155 in the amount of wages paid, $49,561 in the value of property, $86,700 in cash capital, and 7,062,638 pounds in the quantity and $273,940 in the value of the products.

Table showing the extent of the wholesale fishery trade of Lake Superior in 1903.

Item.	No.	Value.
Establishments	16	$10[illegible],414
Employees	99	....
Cash capital	....	142,700
Wages paid	....	58,580

Product.	Lbs.	Value.	Product.	Lbs.	Value.
Cat-fish and bullheads	595	$30	Trout, fresh	4,715,016	$253,333
Eels, salted	200	16	Trout, salted	925,168	21,066
Herring, fresh	2,854,687	55,587	Trout, smoked	130	5
Herring, salted	1,002,322	25,663	White-fish, fresh	930,564	60,142
Herring, smoked	2,275	76	White-fish, salted	42,891	1,777
Pike and pickerel	68,486	3,106	White-fish, smoked	5,432	326
Pike perch (wall-eyed), fresh	172,743	11,512	White-fish (bluefin), fresh	1,668,397	63,500
Pike perch (wall-eyed), salted	370	22	White-fish (bluefin), salted	15,867	564
Sturgeon, fresh	12,661	928	White-fish (bluefin) smoked	39,529	2,091
Sturgeon, smoked	1,316	131	White-fish (longjaw)	246,554	6,831
Suckers, fresh	25,068	501	White-fish (Menominee)	5,820	349
Suckers, salted	134,549	3,360	Yellow perch	10,181	255
			Total	12,880,821	511,171

FISHERIES OF LAKE MICHIGAN.

The total number of persons employed in the fishery industries of Lake Michigan in 1903 was 3,241. Of this number 364 were engaged on vessels, 2,077 in the shore or boat fisheries, and the remaining 800 were shoresmen. The number of persons credited to the several states bordering this lake was as follows: Wisconsin, 1,357; Michigan, 1,193; Illinois, 653; and Indiana, 38.

The investment in the fisheries and related industries amounted to $3,489,187. There were 65 vessels employed, aggregating 1,126 in tonnage and $241,542 in value, including the outfits. The number of boats, including steamers and launches under 5 tons, was 1,298, valued at $144,854. The apparatus of capture in the vessel fisheries consisted of $167,760 worth of gill nets, $1,155 worth of set lines, and 5 pound nets valued at $925. In the shore fisheries the apparatus of capture comprised 975 pound nets, worth $198,035; 20,875 gill nets, worth $101,994; 2,561 fyke nets, worth $32,395; 44 seines, worth $2,384; $2,348 worth of set lines, and a small number of dip nets, spears, and crawfish pots. The shore and accessory property was valued at $1,241,500, and the cash capital amounted to $1,352,450. Of the total investment $2,208,025, or 63 per cent, was credited to Illinois, $674,084 to Wisconsin, $593,595 to Michigan, and $13,483 to Indiana.

The total yield of the fisheries of Lake Michigan in 1903 amounted to 33,579,498 pounds, for which the fishermen received $1,090,550. Of this product the vessel fisheries yielded 8,030,251 pounds, worth

$376,039, and the shore fisheries 25,549,247 pounds, worth $714,511. The principal species in point of value was trout, of which there were taken 9,049,299 pounds, valued at $430,431. Herring amounted to 13,863,617 pounds, worth $347,348, including 94,871 packages of salted herring, for which the fishermen received $240,163. The yield of white-fish was 1,972,594 pounds, worth $118,684; yellow perch, 3,313,388 pounds, worth $63,241; suckers, 2,917,541 pounds, worth $45,262, and bluefin white-fish, 634,664 pounds, for which the fishermen received $24,862. The yield of the fisheries of this lake is divided among the different states as follows: Wisconsin, 19,403,111 pounds, worth $555,469; Michigan, 13,268,476 pounds, worth $500,661; Illinois, 597,689 pounds, worth $23,729, and Indiana, 310,222 pounds, worth $10,691.

The yield of the fisheries of Lake Michigan in 1903 was greater in value than for any previous year for which there are returns, exceeding that for 1899 by $213,807. This is due solely to an increase in the selling price per pound, the average in the earlier year being 2.54 cents, compared with 3.25 in 1903. The product in the two years under comparison shows a decrease in weight of 920,498 pounds. The persons employed in 1899 numbered 3,255, or 14 more than in 1903, and the investment was $2,915,241, or $573,946 less than in the year herein reported.

In 1903 the fisheries of Lake Michigan were more extensive than those of any of the other Great Lakes, exceeding those of Lake Erie, the second in rank, by 514 in the number of persons employed, $1,292,790 in the amount of capital invested, and 10,390,942 pounds in the quantity and $310,535 in the value of the products.

The following tables show the extent of the fisheries of Lake Michigan in 1903:

Table showing by states and counties the number of persons employed in the fisheries of Lake Michigan in 1903.

State and county.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
Michigan:					
Allegan			16		16
Antrim			5		5
Benzie	17		14	6	37
Berrien	29		16	14	59
Charlevoix	53		80	27	160
Delta	14		88		102
Emmet	4		94	7	105
Grand Traverse			33	2	35
Leelanaw		2	73		75
Mackinac			178		178
Manistee			16	1	17
Mason	7		14	3	24
Menominee			174	17	191
Muskegon			13		13
Oceana			6		6
Ottawa	33		8	39	80
Schoolcraft	24		45	15	84
Van Buren			6		6
Total	181	2	879	131	1,193

Table showing by states and counties the number of persons employed in the fisheries of Lake Michigan in 1903—Continued.

State and county.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
Indiana:					
Lake			12		12
Laporte	6		14	2	22
Porter			4		4
Total	6		30	2	38
Illinois:					
Cook			110	516	626
Lake	7		17	3	27
Total	7		127	519	653
Wisconsin:					
Brown			163	74	237
Door	27		430	19	476
Kenosha	6		4	3	13
Kewaunee	7		20	1	28
Manitowoc	12		45	5	62
Marinette			134		134
Milwaukee	60		30	20	110
Oconto			100	2	102
Ozaukee	17		9	8	34
Racine	6		88	3	97
Sheboygan	33		18	13	64
Total	168		1,041	148	1,357
Grand total	362	2	2,077	800	3,241

Table showing by states and counties the apparatus and capital employed in the fisheries of Lake Michigan in 1903.

State and county.	Vessels fishing.				Vessels transporting.				Boats.	
	No.	Tonnage.	Value.	Value of outfit.	No.	Tonnage.	Value.	Value of outfit.	No.	Value.
Michigan:										
Allegan									9	$555
Antrim									3	435
Benzie	3	28	$8,800	$2,975					8	1,690
Berrien	5	127	14,200	4,275					9	2,035
Charlevoix	9	135	22,200	13,150					47	5,860
Delta	2	29	5,750	1,200					68	7,060
Emmet	1	22	500	75					21	2,945
Grand Traverse									19	1,700
Leelanaw					1	10	$1,900	$10	52	4,205
Mackinac									101	9,755
Manistee									9	1,745
Mason	1	30	3,000	950					7	1,700
Menominee									160	10,220
Muskegon									10	985
Oceana									4	475
Ottawa	6	113	19,500	6,175					5	445
Schoolcraft	3	96	20,500	5,645					33	4,035
Van Buren									4	865
Total	30	580	94,450	34,445	1	10	1,900	10	569	56,710
Indiana:										
Lake									11	755
Laporte	1	10	850	600					9	980
Porter									2	45
Total	1	10	850	600					22	1,780
Illinois:										
Cook									40	8,008
Lake	1	28	3,500	1,100					15	1,730
Total	1	28	3,500	1,100					55	9,738

Table showing by states and counties the apparatus and capital employed in the fisheries of Lake Michigan in 1903—Continued.

State and county.	Vessels fishing.				Vessels transporting.				Boats.	
	No.	Tonnage.	Value.	Value of outfit.	No.	Tonnage.	Value.	Value of outfit.	No.	Value.
Wisconsin:										
Brown									143	$14,714
Door	5	51	$9,000	$3,360					291	23,170
Kenosha	1	32	5,500	750					2	820
Kewaunee	1	17	2,000	950					9	4,500
Manitowoc	2	36	3,000	1,150					36	11,788
Marinette									42	3,933
Milwaukee	12	159	29,400	5,862					14	2,610
Oconto									84	7,401
Ozaukee	3	81	16,500	2,725					4	1,750
Racine	1	14	3,000	900					5	1,915
Sheboygan	7	108	16,900	3,690					22	4,025
Total	32	498	85,300	19,387					652	76,626
Grand total	64	1,116	184,100	55,532	1	10	$1,900	$10	1,298	144,854

State and county.	Apparatus of capture—vessel fisheries.					Apparatus of capture—shore fisheries.					
	Pound nets.		Gill nets.		Value of lines.	Pound nets.		Gill nets.		Fyke nets.	
	No.	Value.	No.	Value.		No.	Value.	No.	Value.	No.	Value.
Michigan:											
Allegan						7	$1,400	189	$708		
Antrim						2	400	39	195		
Benzie			570	$2,730		4	800	494	2,650		
Berrien			3,234	12,920		5	1,200	500	1,678		
Charlevoix			2,538	28,146		19	2,600	1,557	7,183		
Delta			750	4,740		61	12,250	847	4,228	18	$240
Emmet	5	$925	40	240		12	3,165	649	3,740		
Grand Traverse						12	1,175	369	1,714		
Leelanaw						36	3,025	828	3,566		
Mackinac						172	15,800	706	3,390		
Manistee								973	3,382		
Mason			180	1,980				612	3,029		
Menominee						141	36,865	148	344		
Muskegon						13	1,650	120	450		
Oceana						5	750	82	236		
Ottawa			3,286	13,018				453	1,435		
Schoolcraft			1,584	15,120		25	5,420	274	1,200		
Van Buren						1	100	34	120		
Total	5	925	12,182	78,894		518	86,600	8,874	39,248	18	240
Indiana.											
Lake						6	1,715	57	238		
Laporte			776	3,650		2	650	197	960	1	30
Porter						1	280	10	46		
Total			776	3,650		9	2,645	264	1,244	1	30
Illinois:											
Cook								557	2,794	6	84
Lake			1,152	7,784		5	1,450	234	1,366	10	150
Total			1,152	7,784		5	1,450	791	4,160	16	234
Wisconsin:											
Brown						28	2,700	1,277	7,056	2,091	25,092
Door			2,234	10,328		212	51,655	4,147	17,194		
Kenosha			708	4,074				125	730		
Kewaunee			110	2,750		2	450	1,291	6,455		
Manitowoc			214	5,560		30	11,800	462	9,905		
Marinette						36	6,910	1,790	7,210	39	585
Milwaukee			5,695	31,155		3	950	474	2,230		
Oconto						111	20,145	505	1,770	396	6,214
Ozaukee			1,585	10,215	$200	3	2,350	375	2,575		
Racine			1,080	5,040				500	2,217		
Sheboygan			2,034	8,310	955	18	10,380				
Total			13,660	77,432	1,155	443	107,340	10,946	57,342	2,526	31,891
Grand total	5	925	27,770	167,700	1,155	975	198,035	20,875	101,994	2,561	32,395

Table showing by states and counties the apparatus and capital employed in the fisheries of Lake Michigan in 1903—Continued.

State and county.	Apparatus of capture—shore fisheries—Cont'd. Seines. No.	Seines. Val.	Value of lines.	Dip nets. No.	Dip nets. Val.	Crawfish pots. No.	Crawfish pots. Val.	Spears. No	Spears. Val.	Shore and accessory property.	Cash capital.	Total investment.
Michigan:												
Allegan										$1,425		$4,088
Antrim										550		1,580
Benzie										8,300		27,945
Berrien			$5							17,715	$1,300	55,328
Charlevoix	7	$168								23,700	1,000	104,007
Delta	6	260	446							3,460	3,000	42,634
Emmet			51							8,485	7,000	27,126
Grand Traverse			11							3,325	1,400	9,325
Leelanaw			5							5,160		17,871
Mackinac	5	220	26					5	$2	4,975		34,168
Manistee										2,655		7,782
Mason										2,000		12,659
Menominee			4							16,690	40,000	104,123
Muskegon										1,040		4,125
Oceana										300		1,761
Ottawa										21,810	11,000	73,383
Schoolcraft	4	155	45							9,675	2,500	64,295
Van Buren										310		1,395
Total	22	803	593					5	2	131,575	67,200	593,595
Indiana:												
Lake			56							250		3,014
Laporte			110							2,150		9,980
Porter			18							100		489
Total			184							2,500		13,483
Illinois:												
Cook	3	86	160	32	$263					959,050	1,219,750	2,190,195
Lake										750		17,830
Total	3	86	160	32	263					959,800	1,219,750	2,208,025
Wisconsin:												
Brown	11	1,075				4,310	$1,050			90,730	60,500	202,917
Door	8	420	1,121							20,115	5,000	141,363
Kenosha										2,100		13,974
Kewaunee										985		18,090
Manitowoc										8,365		51,568
Marinette			42							6,840		25,520
Milwaukee			48							5,550		77,805
Oconto						250	50			5,180		40,760
Ozaukee			200							2,800		39,315
Racine				80	480					2,100		15,652
Sheboygan										2,860		47,120
Total	19	1,495	1,411	80	480	4,560	1,100			147,625	65,500	674,084
Grand total	44	2,384	2,348	112	743	4,560	1,100	5	2	1,241,500	1,352,450	3,489,187

Table showing by states and counties the yield of the fisheries of Lake Michigan in 1903.

State and county.	Black bass.		Buffalo-fish.		Cat-fish and bull-heads.		Eels.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:								
Allegan					275	$9		
Delta	2,930	$279						
Muskegon					35	2		
Total	2,930	279			310	11		
Indiana:								
Lake			630	$26			300	$24
Laporte	20	2	512	15	360	25	250	20
Porter			60	2				
Total	20	2	1,202	43	360	25	550	44
Wisconsin:								
Brown	2,000	160			47,860	1,446		
Door	627	53			570	19		
Marinette					1,400	50		
Oconto					13,920	497		
Sheboygan							177	12
Total	2,627	213			63,750	2,012	177	12
Grand total	5,577	494	1,202	43	64,420	2,048	727	56

State and county.	Fresh-water drum.		German carp.		Herring, fresh.		Herring, salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:								
Allegan	16,000	$160	1,900	$19	3,900	$72		
Berrien	3,900	99	1,770	72	53	2		
Charlevoix					1,450	52		
Delta					108,822	2,358	666,400	16,660
Grand Traverse					5,560	155		
Leelanaw					160	6		
Mackinac					46,000	554	124,000	2,671
Manistee					8,440	305		
Mason					20,630	860		
Menominee					104,555	1,432	3,317,900	83,048
Muskegon	12,900	193			72,700	1,584		
Oceana	100	1			3,000	90		
Ottawa					444,800	19,381		
Schoolcraft					6,282	139		
Van Buren					1,315	22		
Total	32,900	453	3,670	91	827,667	27,012	4,108,300	102,379
Illinois:								
Cook			20,650	776	13,130	479		
Lake	35	1	50	2	80,065	2,282		
Total	35	1	20,700	778	93,195	2,761		
Indiana:								
Lake	6,615	142	3,145	78	34,605	925		
Laporte	1,460	50	5,375	312	38,910	1,290		
Porter	640	20	300	8	2,950	87		
Total	8,715	212	8,820	398	76,465	2,302		
Wisconsin:								
Brown			496,630	7,482	440,250	8,202	9,100	199
Door					895,514	16,726	4,836,300	124,241
Kenosha					59,410	2,355		
Kewaunee					97,830	2,454		
Manitowoc					180,783	4,252	6,400	192
Marinette					218,210	5,394	233,800	5,872
Milwaukee			300	12	263,298	9,669		
Oconto			4,960	128	752,195	9,801	293,200	7,280
Ozaukee					215,144	8,059		
Racine					40,625	1,650		
Sheboygan					213,251	6,333		
Total			501,890	7,622	3,376,540	74,898	5,378,800	137,784
Grand total	41,650	666	535,080	8,889	4,373,867	106,973	9,487,100	240,163

Table showing by states and counties the yield of the fisheries of Lake Michigan in 1903—Continued.

State and county.	Herring, smoked.		Ling or lawyer, fresh.		Ling or lawyer, salted.		Pike and pickerel.		Pike-perch (wall-eyed).	
	Lbs.	Value.	Lbs.	Val.	Lbs.	Val.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Allegan			6,600	$56					1,000	$61
Berrien			11,000	245						
Charlevoix	1,800	$162								
Delta							15,874	$797	108,993	6,353
Emmet	850	50								
Mackinac							9,000	290	18,900	1,043
Manistee					900	$18				
Mason			2,700	22						
Menominee									4,925	320
Muskegon			2,900	23			300	28	1,100	97
Schoolcraft			665	6						
Total	2,650	212	23,865	352	900	18	25,174	1,115	134,918	7,874
Illinois:										
Cook			5,000	95						
Lake			5,820	64						
Total			10,820	159						
Indiana:										
Lake			1,750	35			100	9		
Laporte			6,600	86			15	1	40	4
Porter			550	7						
Total			8,900	128			115	10	40	4
Wisconsin:										
Brown							51,850	3,323	18,240	797
Door							2,870	154	29,910	1,354
Kenosha			3,080	106						
Manitowoc									300	9
Marinette							1,500	75	1,750	95
Milwaukee			29,240	386						
Oconto							9,125	528	31,325	1,632
Ozaukee			30,420	264						
Racine			5,820	59						
Sheboygan			7,360	55						
Total			75,920	870			65,345	4,080	81,525	3,887
Grand total	2,650	212	119,505	1,509	900	18	90,634	5,205	216,483	11,765

State and county.	Sturgeon.		Caviar.		Suckers, fresh.		Suckers, salted.		Trout, fresh.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Michigan:										
Allegan	5,100	$360	530	$402	7,300	$76			8,235	$523
Antrim									3,480	221
Benzie	300	20			8,400	105			310,640	13,771
Berrien	9,925	625	170	150	8,395	339			459,564	22,963
Charlevoix							140,370	$2,834	1,097,343	46,045
Delta	5,067	308	84	54	270,272	2,500	70,800	1,698	283,312	11,306
Emmet	685	35			12,000	100	6,275	150	124,800	6,093
Grand Traverse									35,765	1,668
Leelanaw					80	2	14,420	288	157,020	7,615
Mackinac	10,290	516			207,370	3,432	169,600	3,641	253,385	12,550
Manistee									142,200	6,200
Mason					2,315	36			129,970	6,550
Menominee	910	65			8,350	112	64,500	1,230	40,700	2,005
Muskegon	2,900	178	300	195	19,040	228			5,470	334
Oceana	3,200	240	300	210	2,000	35			20,980	1,055
Ottawa					720	6			370,600	18,724
Schoolcraft	1,003	52			12,000	176	115,700	2,603	641,252	32,020
Van Buren	800	53	70	45	270	6			120	10
Total	40,180	2,452	1,454	1,056	558,512	7,153	581,665	12,444	4,084,836	189,653
Illinois:										
Cook					1,400	39			600	42
Lake	90	6	12	9	5,750	102			198,139	10,859
Total	90	6	12	9	7,150	141			198,739	10,901

Table showing by states and counties the yield of the fisheries of Lake Michigan in 1903—Continued.

State and county.	Sturgeon.		Caviar.		Suckers, fresh.		Suckers, salted.		Trout, fresh.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Indiana:										
Lake	2,875	$207	32	$21	3,355	$58			3,155	$206
Laporte	440	33	12	9	2,950	65			72,687	3,575
Porter	270	19			200	5			590	37
Total	3,585	259	44	30	6,505	128			76,432	3,818
Wisconsin:										
Brown					925,790	9,735				
Door	4,370	246	10	6	19,900	224	173,700	$4,582	1,047,063	46,330
Kenosha									144,906	7,055
Kewaunee					1,650	22			411,492	18,942
Manitowoc	2,656	186			10,089	170			741,234	36,894
Marinette	980	70			221,330	5,370	3,400	85	66,535	2,996
Milwaukee	336	24	5	3	11,750	220			910,849	43,845
Oconto	2,165	131	42	25	321,475	3,367	25,000	620	1,490	74
Ozaukee	308	22	3	2	2,500	40			401,364	19,623
Racine					30,625	763			133,045	7,450
Sheboygan	180	12			16,500	198			737,438	38,631
Total	10,995	691	60	36	1,561,609	20,109	202,100	5,287	4,595,416	221,840
Grand total	54,850	3,408	1,570	1,131	2,133,776	27,531	783,765	17,731	8,955,423	426,212

State and county.	Trout, salted.		Trout (steel-head).		White bass.		White-fish, fresh.		White-fish, salted.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Allegan					100	$6	12,100	$839		
Antrim							6,300	382		
Benzie							138,600	7,429		
Berrien							8,075	657		
Charlevoix	43,426	$1,792					563,372	34,157	8,927	$483
Delta							143,361	8,544	1,400	84
Emmet	30	1					161,425	9,432	50	3
Grand Traverse							55,000	3,159	85	5
Leelanaw	14,920	723					116,350	6,248	61,850	3,584
Mackinac							151,201	8,105	47,900	3,011
Manistee							4,160	261		
Mason							1,840	83		
Menominee	18,100	764					10,350	673	2,000	126
Muskegon							750	57		
Oceana							7,250	460		
Ottawa							300	19		
Schoolcraft							423,920	27,557		
Van Buren							285	21		
Total	76,476	3,280			100	6	1,804,148	108,083	122,212	7,246
Illinois:										
Lake							140	13		
Indiana:										
Lake							1,355	117		
Laporte			9	$1			1,210	110		
Porter							200	16		
Total			9	1			2,765	243		
Wisconsin:										
Brown					300	9				
Door	17,400	939					21,367	1,526		
Kenosha							19	2		
Kewaunee							6,010	388		
Manitowoc			40	5			5,890	403		
Marinette							1,636	108		
Milwaukee							2,162	178		
Oconto							50	3		
Ozaukee							3,787	266		
Racine							78	8		
Sheboygan			120	11			1,950	182		
Total	17,400	939	160	16	300	9	42,979	3,064		
Grand total	93,876	4,219	169	17	400	15	1,850,032	111,403	122,212	7,246

Table showing by states and counties the yield of the fisheries of Lake Michigan in 1903—Continued.

State and county.	White-fish, smoked.		White-fish (bluefin), fresh.		White-fish (bluefin), smoked.		White-fish (longjaw).		White-fish (Menominee), fresh.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Michigan:										
Benzie			15,300	$700	3,000	$300	500	$23		
Berrien			1,200	49						
Charlevoix			29,675	1,253			183,320	7,678	1,750	$55
Delta									23,739	744
Emmet							185	8		
Grand Traverse			5,800	195			2,500	100		
Leelanaw	350	$35	21,105	923						
Manistee			18,300	780						
Mason			50,980	2,125						
Menominee			18,640	475						
Oceana			600	30						
Ottawa			69,600	3,050						
Schoolcraft									20,470	557
Total	350	35	231,200	9,580	3,000	300	186,505	7,809	45,959	1,356
Wisconsin:										
Door			98,250	3,517					43,700	1,244
Kewaunee			56,650	1,582					4,600	110
Marinette			149,795	5,385						
Ozaukee			28,085	1,293					25,575	658
Racine			62,085	2,980						
Sheboygan			5,599	225						
Total			400,464	14,982					73,875	2,012
Grand total	350	35	631,664	24,562	3,000	300	186,505	7,809	119,834	3,368

State and county.	White-fish (Menominee), salted.		Yellow perch, fresh.		Yellow perch, salted.		Crawfish.		Total.	
	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.	Lbs.	Val.
Michigan:										
Allegan			45,000	$1,193					108,040	$3,776
Antrim									9,780	603
Benzie									476,740	22,348
Berrien			27,210	1,060					531,262	26,261
Charlevoix	13,025	$455	69,205	1,238					2,153,663	96,204
Delta			30,927	565					1,731,981	52,250
Emmet			8,200	209	328	$6			314,828	16,087
Grand Traverse									104,710	5,282
Leelanaw			1,000	24					387,255	19,398
Mackinac	62,600	2,810	51,050	767					1,151,296	39,390
Manistee			1,050	42					175,050	7,606
Mason									207,935	9,676
Menominee			8,870	185	5,200	81			3,605,000	90,516
Muskegon			29,200	1,225					147,595	4,144
Oceana			150	4					37,580	2,125
Ottawa			4,450	64					890,470	41,244
Schoolcraft									1,221,301	63,110
Van Buren			11,130	484					13,990	641
Total	75,625	3,265	287,442	7,060	5,528	87			13,268,476	500,661
Illinois:										
Cook			192,270	6,666					233,050	8,097
Lake			74,538	2,294					364,639	15,632
Total			266,808	8,960					597,689	23,729
Indiana:										
Lake			38,985	1,892					96,902	2,940
Laporte			71,010	1,802					201,860	7,400
Porter			5,700	150					11,460	351
Total			115,695	3,044					310,222	10,691
Wisconsin:										
Brown			1,235,630	19,721			236,784	$7,657	3,464,434	58,731
Door	68,800	3,119	610,720	9,302	15,600	244			7,886,671	213,826
Kenosha			18,000	540					225,415	10,058
Kewaunee			600	12					578,862	23,510
Manitowoc			7,450	215					951,842	42,326
Marinette			96,345	1,887					996,711	27,387
Milwaukee			16,800	670					1,231,740	55,007
Oconto			523,400	7,343			7,680	240	1,986,027	31,672
Ozaukee			37,295	651					744,481	30,878
Racine			71,325	3,353					343,608	16,263
Sheboygan			4,750	152					987,325	45,811
Total	68,800	3,119	2,622,315	43,846	15,600	244	244,464	7,897	19,403,111	555,469
Grand total	144,425	6,384	3,292,260	62,910	21,128	331	244,464	7,897	33,579,498	1,090,550

Table showing by states, counties, apparatus, and species the yield of the vessel fisheries of Lake Michigan in 1903.

Apparatus and species.	Indiana.		Illinois.		Michigan.					
	Laporte.		Lake.		Benzie.		Berrien.		Charlevoix.	
	Lbs.	Val.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:										
Herring	18,200	$728	6,325	$253						
Ling, or lawyer	4,000	40	2,100	18			11,000	$245		
Suckers	350	7								
Trout, fresh	71,312	3,487	196,244	10,718	170,500	$7,050	439,750	21,886	947,188	$39,637
Trout, salted									746	24
White-fish, fresh	750	68			107,000	5,710			432,422	27,469
White-fish, salted									3,927	158
White-fish (bluefin)					13,800	610	1,200	49	29,575	1,249
White-fish (longjaw)					500	23			183,100	7,670
Yellow perch			6,388	204						
Total	94,612	4,330	211,057	11,193	291,800	13,393	451,950	22,180	1,596,958	76,207

Apparatus and species.	Michigan—Continued.							
	Delta.		Emmet.		Mason.		Ottawa.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Herring	47,610	$1,587			20,630	$860	431,000	$18,741
Ling, or lawyer					2,700	22		
Suckers	168	3			415	5		
Trout, fresh	122,996	4,427	1,200	$50	31,340	1,690	332,300	16,634
White-fish, fresh	45,073	2,761	4,500	240	1,080	69		
White-fish (bluefin)					50,980	2,125	69,600	3,050
White-fish (Menominee)	6,689	239						
Yellow perch	323	5	200	6				
Total	222,859	9,022	5,900	296	107,145	4,771	832,900	38,425
Pound nets:								
Sturgeon			335	16				
Trout			10,800	450				
White-fish			31,200	1,680				
Total			42,335	2,146				
Grand total	222,859	9,022	48,235	2,442	107,145	4,771	832,900	38,425

Apparatus and species.	Michigan—Continued.				Wisconsin.			
	Schoolcraft.		Total.		Door.		Kenosha.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Herring	1,382	$52	500,622	$21,240	226,664	$6,509	16,250	$715
Ling, or lawyer	665	6	14,365	273			2,800	96
Suckers	6,540	102	7,123	110				
Trout, fresh	556,590	28,302	2,601,864	119,676	327,465	14,027	118,594	5,792
Trout, salted			746	24				
White-fish, fresh	249,714	17,328	839,789	53,577	2,470	155	19	2
White-fish, salted			3,927	158				
White-fish (bluefin)			165,155	7,083				
White-fish (longjaw)			183,600	7,693				
White-fish (Menominee)	30	1	6,719	240	2,400	60		
Yellow perch			523	11				
Total	814,921	45,791	4,324,433	210,085	558,999	20,751	137,663	6,605
Pound nets:								
Sturgeon			335	16				
Trout			10,800	450				
White-fish			31,200	1,680				
Total			42,335	2,146				
Grand total	814,921	45,791	4,366,768	212,231	558,999	20,751	137,663	6,605

Table showing by states, counties, apparatus, and species the yield of the vessel fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Wisconsin.							
	Kewaunee.		Manitowoc.		Milwaukee.		Ozaukee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Herring	46,580	$1,720	71,838	$2,507	188,268	$7,501	167,019	$6,625
Ling, or lawyer					24,390	312	11,240	94
Suckers			139	2				
Trout, fresh	74,950	3,025	108,854	4,747	846,062	40,750	271,787	12,800
White-fish, fresh					102	10	1,435	89
White-fish (bluefin)							24,335	1,141
White-fish (Menominee)							12,500	325
Yellow perch					1,200	36	24,670	430
Total	121,530	4,745	180,831	7,256	1,060,022	48,609	512,986	21,504
Lines:								
Ling, or lawyer							7,700	68
Trout							27,500	1,658
Total							35,200	1,726
Grand total	121,530	4,745	180,831	7,256	1,060,022	48,609	548,186	23,226

Apparatus and species.	Wisconsin—Continued.						Grand total.	
	Racine.		Sheboygan.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Herring			131,131	$5,145	847,750	$30,722	1,372,897	$52,943
Ling, or lawyer	5,400	$50			43,830	552	64,295	883
Suckers					139	2	7,612	119
Trout, fresh	71,260	3,990	116,638	5,691	1,935,610	90,825	4,805,030	224,706
Trout, salted							746	24
White-fish, fresh	10	1			4,036	257	844,575	53,902
White-fish, salted							3,927	158
White-fish (bluefin)	62,085	2,980	5,599	225	92,019	4,346	257,174	11,429
White-fish (longjaw)							183,600	7,693
White-fish (Menominee)					14,900	385	21,619	625
Yellow perch					25,870	466	32,781	681
Total	138,755	7,021	253,368	11,061	2,964,154	127,555	7,594,256	353,163
Pound nets:								
Sturgeon							335	16
Trout							10,800	450
White-fish							31,200	1,680
Total							42,335	2,146
Lines:								
Ling, or lawyer			5,560	42	13,260	110	13,260	110
Trout			352,900	18,962	380,400	20,620	380,400	20,620
Total			358,460	19,004	393,660	20,730	393,660	20,730
Grand total	138,755	7,021	611,828	30,068	3,357,814	148,285	8,030,251	376,039

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903.

Apparatus and species.	Michigan.									
	Allegan.		Antrim.		Benzie.		Berrien.		Charlevoix.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:										
Cat-fish and bullheads	275	$9								
Fresh-water drum	16,000	160					3,900	$99		
German carp	1,900	19					1,270	52		
Herring, fresh	1,900	32								
Ling, or lawyer	600	6								
Pike perch (wall-eyed), fresh	1,000	61								
Sturgeon	5,100	360			300	$20	9,855	620		
Caviar	530	402					170	150		
Suckers, fresh	6,625	70			8,400	105	3,225	132		
Trout, fresh	2,635	135	720	$36	12,640	567	1,200	70	15,500	$675
White bass	100	6								
White-fish, fresh	7,700	506	1,300	72	14,000	671	3,675	305	67,000	3,800
White-fish (Menominee), fresh									150	5
Yellow perch, fresh	1,500	60					3,710	179	1,000	18
Total	45,865	1,826	2,020	108	35,340	1,363	27,005	1,607	83,650	4,498
Gill nets:										
German carp							500	20		
Herring, fresh	2,000	40					53	2	1,450	52
Herring, smoked									1,800	162
Ling, or lawyer, fresh	6,000	50								
Suckers, fresh	675	6					5,170	207		
Trout, fresh	5,600	338	2,760	185	127,500	6,154	18,614	1,007	134,655	5,733
Trout, salted									42,680	1,768
White-fish, fresh	4,400	333	5,000	310	17,600	1,048	4,400	352	63,950	2,888
White-fish, salted									5,000	325
White-fish (bluefin), fresh					1,500	90			100	4
White-fish (bluefin), smoked					3,000	300				
White-fish (longjaw), fresh									220	8
White-fish (Menominee), fresh									1,600	50
White-fish (Menominee), salted									13,025	455
Yellow perch	43,500	1,133					18,500	694	50,605	895
Total	62,175	1,950	7,760	495	149,600	7,592	47,237	2,282	315,085	12,340
Seines:										
Suckers, salted									140,370	2,834
Yellow perch									17,600	325
Total									157,970	3,159
Lines:										
Sturgeon							70	5		
Yellow perch							5,000	187		
Total							5,070	192		
Grand total	108,040	3,776	9,780	603	184,940	8,955	79,312	4,081	556,705	19,997

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Michigan—Continued.							
	Delta.		Emmet.		Grand Traverse.		Leelanaw.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass	2,470	$240						
Herring, fresh	29,705	316			660	$23		
Herring, salted	666,400	16,660						
Pike and pickerel	13,734	699						
Pike perch (wall-eyed), fresh	75,428	4,528						
Sturgeon	5,022	305	350	$19				
Caviar	84	54						
Suckers, fresh	229,948	2,089	12,000	100				
Suckers, salted	70,800	1,698	6,275	150			11,850	$236
Trout, fresh	20,794	829	36,200	1,770	10,805	412	17,120	765
Trout, salted			30	1			2,800	115
White-fish, fresh	42,895	2,240	69,200	4,285	14,800	905	54,500	2,946
White-fish, salted	1,400	84	50	3	85	5	46,800	2,602
White-fish, smoked							350	35
White-fish (bluefin)							155	6
White-fish (Menominee), fresh	2,976	78						
Yellow perch, fresh	18,680	230					1,000	24
Yellow perch, salted			328	6				
Total	1,180,336	30,050	124,433	6,334	26,350	1,345	134,575	6,729
Gill nets:								
Black bass	220	19						
Herring, fresh	31,507	455			4,900	132	160	6
Herring, smoked			850	50				
Pike and pickerel	1,120	51						
Pike perch (wall-eyed)	1,565	93						
Suckers, fresh	3,980	43					80	2
Suckers, salted							2,570	52
Trout, fresh	118,854	5,176	76,000	3,778	20,000	1,002	188,400	6,775
Trout, salted							12,120	608
White-fish, fresh	55,393	3,543	56,525	3,227	40,200	2,254	61,350	3,802
White-fish, salted							15,050	932
White-fish (bluefin), fresh					5,800	195	20,900	915
White-fish (longjaw), fresh			185	8	2,500	100		
White-fish (Menominee), fresh	14,074	427						
Yellow perch	9,921	276	8,000	203				
Total	236,637	10,083	141,560	7,266	73,400	3,683	251,130	12,592
Fyke nets:								
Black bass	240	20						
Pike and pickerel	80	4						
Pike perch (wall-eyed)	160	11						
Suckers	310	6						
Yellow perch	400	16						
Total	1,190	57						
Seines:								
Pike and pickerel	940	43						
Pike perch (wall-eyed)	31,840	1,721						
Sturgeon	45	3						
Suckers, fresh	35,866	359						
Yellow perch	1,600	38						
Total	70,291	2,164						
Lines:								
Trout	20,668	874	600	45	4,960	254	1,500	75
White-fish (bluefin)							50	2
Total	20,668	874	600	45	4,960	254	1,550	77
Grand total	1,509,122	43,228	266,593	13,645	104,710	5,282	387,255	19,398

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Michigan—Continued.							
	Mackinac.		Manistee.		Mason.		Menominee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Herring, fresh	46,000	$554					73,755	$922
Herring, salted	124,000	2,671					3,317,900	83,018
Pike and pickerel	9,000	290						
Pike perch (wall-eyed), fresh	18,900	1,043					4,925	320
Sturgeon	10,290	516					910	65
Suckers, fresh	207,370	3,432					6,850	90
Suckers, salted	103,600	2,195					64,500	1,230
Trout, fresh	136,068	7,206					37,800	1,860
Trout, salted							18,100	764
White-fish, fresh	124,176	6,567					10,350	673
White-fish, salted	47,900	3,011					2,000	126
Yellow perch, fresh	51,050	767					8,870	185
Yellow perch, salted							5,200	81
Total	878,354	28,252					3,551,160	89,364
Gill nets:								
Herring, fresh			8,440	$305			30,800	510
Ling, or lawyer, salted			900	18				
Suckers, fresh					1,900	$31	1,500	22
Trout, fresh	77,760	3,360	142,200	6,200	98,630	4,860	1,250	63
White-fish, fresh	27,025	1,538	4,160	261	260	14		
White-fish (bluefin), fresh			18,300	780			18,640	475
White-fish (Menominee), salted	62,600	2,810						
Yellow perch			1,050	42				
Total	167,385	7,708	175,050	7,606	100,790	4,905	52,190	1,070
Seines:								
Suckers, salted	66,000	1,446						
Lines:								
Trout	38,997	1,950					1,650	82
Spears:								
Trout	560	34						
Grand total	1,151,296	39,390	175,050	7,606	100,790	4,905	3,605,000	90,516

Apparatus and species.	Michigan—Continued.							
	Muskegon.		Oceana.		Ottawa.		Schoolcraft.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Cat-fish and bullheads	35	$2						
Fresh-water drum	12,900	193	100	$1				
Herring, fresh	65,500	1,284	3,000	90			1,650	$22
Ling, or lawyer	2,900	23						
Pike and pickerel	300	28						
Pike perch (wall-eyed), fresh	1,100	97						
Sturgeon	2,900	178	3,200	240			1,003	52
Caviar	300	195	300	210				
Suckers, fresh	19,040	228	2,000	35			4,260	54
Suckers, salted							46,500	1,046
Trout, fresh	1,870	124	9,000	450			48,892	2,057
White-fish, fresh	750	57	7,250	460			146,455	8,570
Yellow perch, fresh	9,200	550	150	4				
Total	116,795	2,959	25,000	1,490			248,760	11,801
Gill nets:								
Herring, fresh	7,200	300			13,800	$640	3,250	65
Suckers, fresh					720	6	1,200	20
Trout, fresh	3,600	210	11,980	605	38,300	2,080	32,930	1,499
White-fish, fresh					300	19	27,760	1,659
White-fish (bluefin), fresh			600	30				
White-fish (Menominee), fresh							20,440	556
Yellow perch	20,000	675			4,450	64		
Total	30,800	1,185	12,580	635	57,570	2,819	85,580	3,799
Seines:								
Suckers, salted							69,200	1,557
Lines:								
Trout							2,840	162
Grand total	147,595	4,144	37,580	2,125	57,570	2,819	406,380	17,319

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Michigan.				Indiana.			
	Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass			2,470	$240			20	$2
Buffalo-fish					630	$26	412	10
Cat-fish and bullheads			310	11				
Eels					300	24	250	20
Fresh-water drum			32,900	453	6,615	142	1,460	50
German carp			3,170	71	3,145	78	2,125	52
Herring, fresh	1,200	$20	223,370	3,263	32,065	870	13,210	422
Herring, salted			4,108,300	102,379				
Ling or lawyer			3,500	29	900	18	600	20
Pike and pickerel			23,034	1,017	100	9	15	1
Pike perch (wall-eyed), fresh			101,353	6,049				
Sturgeon	800	53	39,730	2,428	2,330	164	270	20
Caviar	70	45	1,454	1,056			12	9
Suckers, fresh	90	2	499,808	6,337	3,055	52	600	13
Suckers, salted			303,525	6,555				
Trout, fresh			351,244	16,956	2,615	170	750	48
Trout, salted			20,930	880				
Trout, steelhead							9	1
White-bass			100	6				
White-fish, fresh	175	11	564,226	32,068	1,320	114	250	22
White-fish, salted			98,235	5,831				
White-fish, smoked			350	35				
White-fish (bluefin)			155	6				
White-fish (Menominee), fresh			3,126	83				
Yellow perch, fresh	530	14	95,690	2,031	23,275	690	2,250	110
Yellow perch, salted			5,528	87				
Total	2,865	145	6,482,508	187,871	76,350	2,357	22,233	800
Gill nets:								
Black bass			220	19				
German carp			500	20				
Herring, fresh	115	2	103,675	2,509	2,540	55	7,500	140
Herring, smoked			2,650	212				
Ling or lawyer, fresh			6,000	50				
Ling or lawyer, salted			900	18				
Pike and pickerel			1,120	51				
Pike perch (wall-eyed)			1,565	93				
Suckers, fresh	180	4	15,405	341	300	6		
Suckers, salted			2,570	52				
Trout, fresh	120	10	1,049,153	49,095	300	18		
Trout, salted			54,800	2,376				
White-fish, fresh	110	10	368,933	20,758	35	3	210	20
White-fish, salted			20,050	1,257				
White-fish (bluefin), fresh			65,840	2,489				
White-fish (bluefin), smoked			3,000	300				
Whitefish (longjaw), fresh			2,905	116				
White-fish (Menominee), fresh			36,114	1,033				
White-fish (Menominee), salted			75,625	3,265				
Yellow perch	10,000	470	166,629	4,452	12,550	310	62,310	1,530
Total	11,125	496	1,977,654	88,506	15,725	392	70,020	1,690
Fyke nets:								
Black bass			240	20				
Buffalo-fish							100	5
Cat-fish and bullhead							360	25
German carp							3,250	260
Pike and pickerel			80	4				
Pike perch (wall-eyed)			160	11			40	4
Suckers			310	6			2,000	45
Yellow perch			400	16			200	12
Total			1,190	57			5,950	351
Seines:								
Pike and pickerel			940	43				
Pike perch (wall-eyed)			31,840	1,721				
Sturgeon			45	3				
Suckers, fresh			35,866	359				
Suckers, salted			275,570	5,837				
Yellow perch			19,200	363				
Total			363,461	8,326				

Table showing by states, counties, apparatus and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Michigan.				Indiana.			
	Van Buren.		Total.		Lake.		Laporte.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Lines:								
Ling or lawyer					850	$17	2,000	$26
Sturgeon			70	$5	545	43	170	13
Caviar					32	21		
Trout			71,215	3,442	240	18	625	40
White-fish (bluefin)			50	2				
Yellow perch			5,000	187	3,160	92	6,250	150
Total			76,335	3,636	4,827	191	9,045	229
Spears:								
Trout			560	34				
Grand total	13,990	$641	8,901,708	288,430	96,902	2,940	107,248	3,070

Apparatus and species.	Indiana.				Illinois.					
	Porter.		Total.		Cook.		Lake.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:										
Black bass			20	$2						
Buffalo-fish	60	$2	1,102	38						
Eels			550	44						
Fresh-water drum	640	20	8,715	212			35	$1	35	$1
German carp	300	8	5,570	138			50	2	50	2
Herring, fresh	2,650	81	47,925	1,373			52,500	1,130	52,500	1,130
Ling or lawyer	50	2	1,550	40			720	11	720	11
Pike and pickerel			115	10						
Sturgeon	180	12	2,780	196			90	6	90	6
Caviar			12	9			12	9	12	9
Suckers, fresh	200	5	3,855	70			1,500	30	1,500	30
Trout, fresh	250	16	3,615	234			560	45	560	45
Trout, steelhead			9	1						
White-fish, fresh	200	16	1,770	152			140	13	140	13
Yellow perch, fresh	1,400	44	26,925	844			19,600	480	19,600	480
Total	5,930	206	104,513	3,363			75,207	1,727	75,207	1,727
Gill nets:										
Herring, fresh	300	6	10,340	201	12,530	$455	21,240	899	33,770	1,354
Ling or lawyer, fresh					500	5	2,400	26	2,900	31
Suckers, fresh			300	6	250	7	4,250	72	4,500	79
Trout, fresh	100	6	400	24	600	42	1,335	96	1,935	138
White-fish, fresh			215	23						
Yellow perch	3,100	70	77,900	1,910	95,820	3,061	44,600	1,470	140,420	4,531
Total	3,500	82	89,215	2,164	109,700	3,570	73,825	2,563	183,525	6,133
Dip nets:										
Herring					600	24			600	24
Yellow perch					22,500	1,125			22,500	1,125
Total					23,100	1,149			23,100	1,149
Fyke nets:										
Buffalo-fish			100	5						
Cat-fish and bullheads			360	25						
German carp			3,250	260	1,250	50			1,250	50
Ling or lawyer							600	9	600	9
Pike perch (wall-eyed)			40	4						
Suckers			2,000	45						
Yellow perch			200	12	2,600	130	3,950	140	6,550	270
Total			5,950	351	3,850	180	4,550	149	8,400	329
Seines:										
German carp					19,400	726			19,400	726
Suckers, fresh					1,150	32			1,150	32
Total					20,550	758			20,550	758
Lines:										
Ling or lawyer	500	5	3,350	48	4,500	90			4,500	90
Sturgeon	90	7	805	63						
Caviar			32	21						
Trout	240	15	1,105	73						
Yellow perch	1,200	36	10,610	278	71,350	2,350			71,350	2,350
Total	2,030	63	15,402	483	75,850	2,440			75,850	2,440
Grand total	11,460	351	215,610	6,361	233,050	8,097	153,582	4,439	386,632	12,536

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Wisconsin.							
	Brown.		Door.		Kenosha.		Kewaunee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass			627	$53				
Cat-fish and bullheads	900	$29	570	19				
Herring, fresh	109,910	1,892	591,310	7,846			48,000	$640
Herring, salted	9,100	199	4,836,300	124,241				
Pike and pickerel	1,000	60	2,870	154				
Pike perch (wall-eyed), fresh	3,100	167	28,710	1,282				
Sturgeon			4,370	246				
Caviar			10	6				
Suckers, fresh	9,500	108	19,900	224				
Suckers, salted			92,200	2,250				
Trout, fresh			89,228	4,094			720	33
Trout, salted			17,400	939				
White-fish, fresh			2,267	133				
White-fish (Menominee), fresh			700	24				
White-fish (Menominee), salted			4,800	196				
Yellow perch, fresh	10,850	167	482,480	6,069			600	12
Yellow perch, salted			15,600	244				
Total	144,660	2,622	6,189,342	148,020			49,320	685
Gill nets:								
Herring, fresh	328,740	6,290	77,540	2,371	43,160	$1,040	3,250	94
Ling or lawyer, fresh					280	10		
Pike and pickerel	3,350	198						
Pike perch (wall-eyed)	2,200	98						
Suckers, fresh	61,250	604					1,650	22
Trout, fresh			506,100	22,649	26,312	1,263	335,822	15,884
White-fish, fresh			16,030	1,238			6,040	388
White-fish (bluefin), fresh			98,250	3,517			56,650	1,582
White-fish (Menominee), fresh			40,600	1,160			4,600	110
White-fish (Menominee), salted			64,000	2,923				
Yellow perch	357,680	7,942	123,740	3,098	18,000	540		
Total	753,220	15,132	926,860	36,956	87,752	3,453	408,012	18,080
Fyke nets:								
Black bass	2,000	160						
Cat-fish and bullheads	41,320	1,202						
German carp	133,530	2,952						
Herring	1,600	20						
Pike and pickerel	32,500	2,165						
Pike perch (wall-eyed)	12,640	532						
Suckers	828,640	8,758						
White bass	300	9						
Yellow perch	860,850	11,502						
Total	1,913,380	27,300						
Seines:								
Cat-fish and bullheads	5,640	215						
German carp	363,100	4,530						
Pike and pickerel	15,000	900						
Suckers, fresh	26,400	265						
Suckers, salted			81,500	2,332				
Yellow perch	6,250	110						
Total	416,390	6,020	81,500	2,332				
Lines:								
Pike perch (wall-eyed)			1,200	72				
Trout			124,270	5,560				
Yellow perch			4,500	135				
Total			129,970	5,767				
Crawfish pots:								
Crawfish	236,784	7,657						
Grand total	3,464,434	58,731	7,327,672	193,075	87,752	3,453	457,332	18,765

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Wisconsin.									
	Manitowoc.		Marinette.		Milwaukee.		Oconto.		Ozaukee.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:										
Cat-fish and bullheads							560	$15		
German carp							160	8		
Herring, fresh	99,975	$1,498	103,040	$1.320	37,650	$712	589,145	7,077	12,500	$220
Herring, salted	6,400	192	233,800	5,872			293,200	7,280		
Ling or lawyer									1,680	15
Pike and pickerel							3,050	200		
Pike perch (wall-eyed), fresh	300	9					14,725	802		
Sturgeon	2,376	166	980	70	336	24	2,165	131	308	22
Caviar					5	3	42	25	3	2
Suckers, fresh	9,950	168	27,420	380	11,250	200	127,010	1,361	2,500	40
Suckers, salted			3,400	85			25,000	620		
Trout, fresh	221,640	12,522	1,920	96	6,250	305	1,490	74	58,337	2,833
Trout, steelhead	40	5								
White-fish, fresh	4,100	265	1,256	82	2,060	168	50	3	1,412	115
White-fish (Menominee), fresh									250	7
Yellow perch, fresh	2,050	67	34,115	567			357,640	4,545	375	14
Total	346,831	14,892	405,931	8,472	57,551	1,412	1,414,237	22,141	77,365	3,268
Gill nets;										
German carp					300	12				
Herring, fresh	8,970	247	114,600	4,065	37,380	1,456	161,250	2,705	35,625	1,214
Ling or lawyer, fresh					1,600	26			4,200	35
Sturgeon	280	20								
Suckers, fresh			182,810	4,875	500	20	1,250	25		
Trout, fresh	410,740	19,625	57,415	2,600	58,537	2,790			22,500	1,164
White-fish, fresh	1,790	138	380	26					940	62
White-fish (bluefin), fresh			149,795	5,385					3,750	152
White-fish (Menominee), fresh									12,825	326
Yellow perch	5,400	148			10,200	408	15,980	450	12,250	207
Total	427,180	20,178	505,000	16,951	108,517	4,712	178,480	3,180	92,090	3,160
Fyke nets:										
Cat-fish and bullheads			1,400	50			13,360	482		
German carp							4,800	120		
Herring			600	9			1,800	22		
Pike and pickerel			1,500	75			6,075	328		
Pike perch (wall-eyed)			1,750	95			16,600	830		
Suckers			11,100	115			193,215	1,981		
Yellow perch			62,230	1,320			149,780	2,348		
Total			78,580	1,664			385,630	6,111		
Lines:										
Ling or lawyer					3,250	48			5,600	52
Trout			7,200	300					21,240	1,168
Yellow perch					5,400	226				
Total			7,200	300	8,650	274			26,840	1,220
Crawfish pots:										
Crawfish							7,680	240		
Grand total	774,011	35,070	996,711	27,387	174,718	6,398	1,986,027	31,672	196,295	7,648

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Wisconsin.						Grand total.	
	Racine.		Sheboygan.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass					627	$53	3,117	$295
Buffalo-fish							1,102	38
Cat-fish and bullheads					2,030	63	2,340	74
Eels			177	$12	177	12	727	56
Fresh-water drum							41,650	666
German carp					160	8	8,950	219
Herring, fresh			82,120	1,188	1,673,650	22,393	1,997,445	28,159
Herring, salted					5,378,800	137,784	9,487,100	240,163
Ling or lawyer			1,800	13	3,480	28	9,250	108
Pike and pickerel					6,920	414	30,069	1,441
Pike perch (wall-eyed), fresh					47,135	2,260	148,488	8,309
Sturgeon			180	12	10,715	671	53,315	3,801
Caviar					60	36	1,538	1,110
Suckers, fresh			16,500	198	224,030	2,679	729,193	9,116
Suckers, salted					120,600	2,955	424,125	9,510
Trout, fresh			267,900	13,975	647,485	33,932	1,002,904	51,167
Trout, salted					17,400	939	38,330	1,819
Trout, steelhead			120	11	160	16	169	17
White bass							100	6
White-fish, fresh			1,950	182	13,095	948	579,231	33,181
White-fish, salted							98,235	5,831
White-fish, smoked							350	35
White-fish (bluefin)							155	6
White-fish (Menominee), fresh					950	31	4,076	114
White-fish (Menominee), salted					4,800	196	4,800	196
Yellow perch, fresh			4,750	152	892,860	11,593	1,035,075	14,948
Yellow perch, salted					15,600	244	21,128	331
Total			375,497	15,743	9,060,734	217,255	15,722,962	410,216
Gill nets:								
Black bass							220	19
German carp					300	12	800	32
Herring, fresh	15,625	$650			826,140	20,732	973,925	24,796
Herring, smoked							2,650	212
Ling or lawyer, fresh	420	9			6,500	80	15,400	161
Ling or lawyer, salted							900	18
Pike and pickerel					3,350	198	4,170	249
Pike perch (wall-eyed)					2,200	98	3,765	191
Sturgeon					280	20	280	20
Suckers, fresh	625	13			218,085	5,559	268,290	5,985
Suckers, salted							2,570	52
Trout, fresh	61,785	3,460			1,479,211	69,435	2,530,699	118,692
Trout, salted							54,800	2,376
White-fish, fresh	68	7			25,848	1,859	395,026	22,640
White-fish, salted							20,050	1,257
White-fish (bluefin), fresh					308,445	10,636	371,285	13,125
White-fish (bluefin), smoked							3,000	300
White-fish (longjaw), fresh							2,905	116
White-fish (Menominee), fresh					58,025	1,596	94,139	2,629
White-fish (Menominee), salted					64,000	2,923	139,625	6,188
Yellow perch	21,325	853			564,575	13,646	949,584	24,589
Total	99,818	4,992			3,586,959	126,794	5,837,383	223,597
Dip nets:								
Herring	25,000	1,000			25,000	1,000	25,600	1,024
Suckers	30,000	750			30,000	750	30,000	750
Yellow perch	50,000	2,500			50,000	2,500	72,500	3,625
Total	105,000	4,250			105,000	4,250	128,100	5,399
Fyke nets:								
Black bass					2,000	160	2,240	180
Buffalo-fish							100	5
Cat-fish and bullheads					56,080	1,734	56,440	1,759
German carp					138,330	3,072	142,830	3,382
Herring					4,000	51	4,000	51

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Michigan in 1903—Continued.

Apparatus and species.	Wisconsin.						Grand total.	
	Racine.		Sheboygan.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fyke nets—Continued.								
Ling or lawyer							600	$9
Pike and pickerel					40,075	$2,568	40,155	2,572
Pike perch (wall-eyed)					30,990	1,457	31,190	1,472
Suckers					1,032,955	10,854	1,035,265	10,905
White bass					300	9	300	9
Yellow perch					1,072,860	15,170	1,080,010	15,468
Total					2,377,590	35,075	2,393,130	35,812
Seines:								
Cat-fish and bullheads					5,640	215	5,640	215
German carp					363,100	4,530	382,500	5,256
Pike and pickerel					15,000	900	15,940	943
Pike perch (wall-eyed)							31,840	1,721
Sturgeon							45	3
Suckers, fresh					26,400	265	63,416	656
Suckers, salted					81,500	2,332	357,070	8,169
Yellow perch					6,250	110	25,450	473
Total					497,890	8,352	881,901	17,436
Lines:								
Ling or lawyer					8,850	100	16,700	238
Pike perch (wall-eyed)					1,200	72	1,200	72
Sturgeon							875	68
Caviar							32	21
Trout					152,710	7,028	225,030	10,543
White-fish (bluefin)							50	2
Yellow perch					9,900	361	96,860	3,176
Total					172,660	7,561	340,747	14,120
Spears:								
Trout							500	31
Crawfish pots:								
Crawfish					241,464	7,897	241,464	7,897
Grand total	204,848	$9,242	375,497	$15,743	16,045,297	407,184	25,519,247	714,511

WHOLESALE FISHERY TRADE OF CHICAGO AND GREEN BAY.

The wholesale fishery trade of Lake Michigan centers chiefly at Chicago, Ill., and Green Bay, Wis. In Chicago in 1903 there were 46 establishments, of which number 11 were in the fresh-fish trade, including oysters and other products, 3 in the oyster trade exclusively, 16 were fish brokers, salt-fish dealers, and wholesale grocers handling salted fish, and 16 were engaged in the smoked-fish trade. The number of persons employed was 516, the value of property utilized was $957,300, and the cash capital amounted to $1,219,750. The products consisted of fresh fish, 37,943,566 pounds, valued at $2,438,804; salted fish, 24,818,100 pounds, valued at $1,374,961; smoked fish, 3,407,325 pounds, valued at $252,245; lobsters, 258,415 pounds, valued at $51,565; shrimp, 113,285 pounds, valued at $10,815; oysters, 744,980 gallons, valued at $898,181, and 10,355 barrels in the shell, valued at $80,957; and clams, 4,712 barrels, valued at $26,584; a total value of $5,134,112. The products are shown in detail in the following table:

Table showing products in wholesale fishery trade of Chicago in 1903.

Product.	Lbs.	Value.	Product.	Lbs.	Value.
Fresh fish:			Salted fish—Continued.		
Black bass	551,016	$65,624	Herring, domestic	1,016,000	$26,998
Blue-fish	406,597	29,179	Herring, imported	11,940,200	596,924
Buffalo-fish	282,368	15,542	Lake herring	1,925,000	51,975
Cat-fish and bullheads	283,985	18,562	Mackerel, domestic	92,000	8,670
Chubs	1,134,224	63,885	Mackerel, imported	1,132,400	133,087
Cod	357,291	21,378	Salmon	1,082,000	56,880
Flounders	122,082	7,243	Stock-fish	391,600	45,086
Fresh-water drum	162,294	4,143	Suckers	195,000	5,460
German carp	1,275,558	42,653	Trout	174,000	10,440
Haddock	104,033	5,234	White-fish	51,000	3,825
Halibut	2,134,469	177,717			
Lake herring	3,582,968	194,983	Total	24,818,100	1,374,961
Mackerel	142,810	14,519			
Pike and pickerel	704,915	38,224	Smoked fish:		
Pike, grass	696,532	34,820	Chubs	1,468,500	121,250
Pike perch (wall-eyed)	2,473,656	165,880	Finnan haddie	40,025	2,630
Red snappers	546,966	43,369	Herring	912,500	22,830
Salmon	1,422,049	118,470	Lake herring	465,000	35,240
Shad	309,694	28,293	Salmon	136,000	17,680
Smelt	797,720	62,492	Sturgeon	153,300	23,705
Spanish mackerel	102,604	12,228	Trout	92,000	11,850
Sturgeon, lake	102,037	12,240	White-fish	20,000	2,460
Suckers	1,528,427	38,670	Miscellaneous	120,000	14,600
Trout	8,323,801	533,007			
White-fish	5,467,975	431,465	Total	3,407,325	252,245
White-fish (bluefin)	1,921,119	96,367			
Yellow perch	2,662,635	142,329	Other products:		
Miscellaneous	343,741	20,288	Lobsters	258,415	51,565
			Shrimp	113,285	10,815
Total	37,943,566	2,438,804	Oysters, opened..galls.	714,980	898,181
			Oysters, in shell..bbls.	10,355	80,957
Salted fish:			Clams ....do.	4,712	26,584
Anchovies	182,000	9,036			
Cod, dried	2,120,300	116,700	Total	....	1,068,102
Cod, boneless	4,421,600	301,460			
Eels	95,000	8,420	Total value	....	5,134,112

In the wholesale fishery trade of Green Bay there were 5 establishments. The number of persons employed was 71, the value of property $84,760, and the cash capital $60,500. The products consisted of fresh and salted fish, crawfish, and oysters, and amounted to 9,351,642 pounds, valued at $362,944. The quantity and value of the various species handled are given in the following table:

Statement of the wholesale fish trade of Green Bay, Wis., in 1903.

Product.	Pounds.	Value.	Product.	Pounds.	Value.
Black bass	3,740	$378	White-fish	179,607	$13,440
Blue-fish	15,006	1,240	White-fish (bluefin)	105,739	4,810
Cat-fish and bullheads	32,667	2,403	Yellow perch	1,978,194	64,060
German carp	624,655	18,882	Other fish	52,724	1,905
Lake herring	860,177	31,550	Salted fish	3,140,500	91,850
Pike and pickerel	309,242	22,292	Crawfish	217,000	8,750
Pike perch (wall-eyed pike)	264,737	20,010	Oysters	110,847	13,644
Suckers	937,440	20,830			
Trout	482,262	31,920	Total	9,351,642	362,944
White bass	37,105	1,980			

FISHERIES OF LAKE HURON.

Fisheries are conducted on the American side of Lake Huron from Detour to Port Huron, but by far the most valuable fishing grounds are in Saginaw Bay. The fisheries in St. Marys River as far up as Sailors Encampment, those in Saginaw River up to a short distance

above Saginaw, and those in Cheboygan River during the spring are included in the statistics for Lake Huron.

The number of persons employed in the fisheries of Lake Huron in 1903 was 1,704, of whom 51 were engaged on vessels fishing, 16 on vessels transporting, 1,450 in the shore or boat fisheries, and 187 were shoresmen employed in various capacities.

The investment in the fisheries of this lake amounted to $851,639. There were 15 fishing and transporting vessels of 188 net tons, valued at $45,700 and their outfits at $12,995; 606 boats, including 5 steam tugs under 5 tons, $4,600, valued at $45,173; and 22 gasoline launches, valued at $22,550, were used. The fishing apparatus employed in the vessel fisheries was valued at $25,625 and in the shore or boat fisheries at $216,981. The shore and accessory property was valued at $387,115 and the cash capital amounted to $95,500. The products of the fisheries aggregated 14,455,209 pounds, valued at $450,318, of which 12,891,079 pounds, valued at $372,886, were taken in the shore fisheries, and 1,564,130 pounds, valued at $77,432, in the vessel fisheries.

Since 1899, the year for which the last canvass was made, there has been an increase in the fisheries of Lake Huron of 463 in the number of persons employed, $376,686 in the amount of capital invested, and 2,036,882 pounds, or about 16 per cent, in the quantity, and $142,240, or 46 per cent, in the value of the products. There has been a substantial increase in the catch of all the more important commercial species except yellow perch, which, while decreasing in quantity, has increased in value. Most of the increases may be traced to the new fisheries established between Alpena and Saginaw Bay and to the larger number of persons employed.

The most productive forms of apparatus used in this lake are pound nets, gill nets, fyke nets, and trap nets. Pound nets are used along the entire shore of the lake, but the most profitable catches are taken in Saginaw Bay, which is well adapted to this method of fishing. Since 1899 quite extensive pound-net fisheries have been established in the vicinity of Alpena and along the shore south of that town to Saginaw Bay. The men engaged are mostly from Bay City and vicinity. In the vicinity of Alpena the pound nets are set in from 20 to 40 feet of water, the depth decreasing south of that place. In 1903 these fisheries were quite successful, but in 1904 they were almost a total failure, due, it is thought, to the cool summer.

Some of the Bay City dealers either have offices at Alpena during the summer or employ agents to visit along the shore and buy fish of the fishermen. One of these dealers employed a 50-horsepower gasoline launch to transport fish from the pound nets in that vicinity. During 1904, however, fish were so scarce that the use of such a large boat proved unprofitable, and it was sold. Practically all of the fish taken in Saginaw Bay are sold in Bay City. Some of the dealers,

to induce men to engage in fishing, furnish them with twine and in return are allowed to handle their catch. The dealers retain from a third to half of the catch, according to the amount of twine furnished, and pay the fishermen the prevailing market prices for the remainder. In many instances this has proved a disastrous venture for the dealer, as he runs the risk of a poor fishing season and the tendency of the fishermen to sell to the dealer offering the highest prices, notwithhstanding their contract. In addition, the same care of the nets can not be expected from the fishermen as if they were the sole owners.

The pound-net season in Saginaw Bay is from about the first of April until early in July, when the nets are taken up, to be set again about the middle of September and allowed to remain down until the latter part of November. The depth of water in which they are set varies from 8 to 35 feet, though comparatively few are set in more than 20 feet of water. It is only when a long string of nets is set that a greater depth is reached. The sizes of mesh in the pound nets along the lake are from 5 to 8 inches in the leaders, 4 to 6 inches in the hearts, and 2 to 4 inches in the cribs or pots. In some instances where the mesh in the sides of the cribs is 2½ inches, those in the ends are 2¼ inches. The length of pound-net leaders varies from 275 to 550 yards. In the Saginaw River, which is only a few hundred feet wide, the length of the leaders is necessarily much less. Owing to the rocky character of the bottom between Saginaw Bay and Port Huron, and the difficulty necessarily encountered in driving stakes, pound-net fishing is not followed very generally along that portion of the lake, one firm usually doing most of the fishing done in a locality.

The value of pound nets in Lake Huron varies from $25 to $400 each, according to the depth of water in which they are set. An average value would be about $150 each. A pound net ordinarily will last about four years, its length of service depending upon the care taken of it, the character of the fishing grounds, and the weather encountered. The most valuable species taken in pound nets are herring, wall-eyed pike, white-fish, yellow perch, and suckers.

Gill nets rank second in importance among the different forms of apparatus. They are used along the entire length of the lake, though to a rather limited extent in Saginaw Bay. Over two-thirds of their entire catch was taken by steam vessels, including three from Alpena, two from Ausable, and one each from Cheboygan, Rogers, and Harbor Beach. When steamers are used gill nets are set in from 25 to 100 fathoms of water, while with sailboats the depth varies from 8 to 40 fathoms. Trout is by far the most important species caught in gill nets, though large catches of white-fish, Menominee white-fish, yellow perch, wall-eyed pike, and suckers are taken. Between Saginaw Bay and Port Huron gill nets are very commonly used during the summer, between the spring and fall pound-net seasons, in taking yellow perch

and occasionally Menominee white-fish. The sizes of mesh used in gill nets varies from 3 to 4½ inches, the former size being used mostly for perch. Gill nets are set in varying depths of water up to 100 fathoms, the latter being found off Thunder Bay light, near Alpena, where some of the deepest water in the lake occurs. The same method of preserving gill nets is followed as on some of the other Great Lakes, that of allowing them to remain from fifteen to twenty-five minutes in boiling water in which hemlock bark has been placed. At Alpena it is customary for the fishermen to buy hemlock sirup from the tanneries located there. This costs 75 cents a gallon, and is about as thick as molasses, 1 quart being used to 40 gallons of water.

The catch by fyke nets ranks next in quantity to that of gill nets, though of far less value. The most of these nets are used in Saginaw River.

Trap nets are used in various localities from Detour to Harbor Beach, but very seldom below the latter town. These nets are set in from 4 to 15 feet of water and catch principally suckers, except in a few localities where yellow perch and wall-eyed pike predominate. They are often set in January and allowed to remain until the following fall, being removed from the water while the ice is breaking up in the spring and making in the fall, to prevent injury to them. These nets are very convenient to move from one ground to another, as, instead of stakes, anchors weighing from 5 to 35 pounds each are used to hold them in position. Two sizes of anchors are commonly used for each net, the larger ones for the "outhauls," or back of the net, to hold the pot in position, and the smaller ones for the heart. Trap nets are sometimes entirely submerged, while in very shallow water a portion of the net extends above the surface. When submerged the nets are located by buoys, except when the owner does not desire their location known, in which case he has a system of his own for marking them. The legislature of Michigan, in 1904, passed an act prohibiting the use of trap nets in Lake Huron after January 1, 1905.

Seines are used at very few localities along the lake, the most important seine fishery being located at Pine River, Arenac County. The principal species taken were wall-eyed pike and suckers. At Cheboygan the catch was confined exclusively to white-fish, while at Ausable and Oscoda both suckers and white-fish were taken.

An important fishery with spears is conducted during the winter in Saginaw Bay near the mouth of the Saginaw River, from the 1st of January until the latter part of March, the length of the season varying according to the severity of the winter. Four hundred shanties may sometimes be seen on the ice at one time during the height of the season. There is usually one man to a shanty, which is from 4 to 5 feet square and is heated by a small stove, the entire outfit costing about $15. The spears have a handle from 8 to 10 feet long, to which

is fastened a line 16 feet long. The catch is sold to local buyers, who drive on the ice among the fishermen while the latter are at work. These buyers ship very few fish, but sell to the wholesale dealers in Bay City.

The most valuable species taken in Lake Huron are, in the order of their importance, trout, wall-eyed pike, herring, suckers, yellow perch, and white-fish. With the exception of herring and suckers, the greater part of which are salted, they are sold mostly in a fresh condition. Practically the entire catch of trout, except a few taken in pound nets and trap nets, is caught in gill nets at depths ranging from 8 to 100 fathoms, or an average of about 50 fathoms. The greater part of the catch is taken north of Saginaw Bay, where the water is deeper and more suitable for them. There is also a profitable trout fishing ground off Harbor Beach, but the season there is considerably shorter than in the upper part of the lake. The spawning grounds for trout are so far distant from this place that it takes two days to reach them and return. The distance is too great for the sailboats, and the one tug in this locality seldom visits those grounds. For this reason very few trout are taken after the 1st of August, when they begin moving farther out in the lake toward their spawning grounds. The average weight of trout in Lake Huron ranges from 3 to 8 pounds, the larger ones being taken during the summer in deep water. Trout are usually eviscerated when sold, because otherwise they do not keep so long as many of the other species.

Practically the entire catch of wall-eyed pike is taken in the shore fisheries and mainly in pound nets. The most prolific fishing grounds are in Saginaw Bay, where these fish are taken in large quantities, especially during the spring, while on their way to the rivers to spawn. The average weight of those taken in Lake Huron is from 2 to 3 pounds each. It is said that in some localities the size was greater in 1903 than for many years. As there is a constant demand for wall-eyed pike they are usually sold fresh.

Herring are very plentiful in Saginaw Bay, and many of the pound-net fishermen depend almost entirely upon this fish for their profit. As the demand for fresh herring is not great, the catch is usually salted and put up by the fishermen in kegs, or half barrels, holding about 115 pounds each. After the fish are received by the dealers they are often removed from these kegs and repacked in buckets holding from 6 to 20 pounds, in kegs holding from 20 to 50 pounds, called quarters, and in kegs holding from 70 to 115 pounds, called halves. In repacking, a new supply of salt is necessary, for the fish have absorbed most of the salt originally used. In the preparation for salting the herring are cut either down the back or the belly, but usually the former. When cut down the back they are called "flats," and when cut down the belly they are termed "ciscoes." The former

bring a slightly higher price owing to the fact that they pack better, and more can be put in a package. They also absorb the salt better than "ciscoes." In some instances salt herring are sold under the trade name of "family white fish." Lake Huron herring average in weight from one-third to three-fourths of a pound, though an occasional one weighing 3 pounds is taken.

Suckers are caught from Detour to Port Huron, but the largest quantities are taken in the lake off Cheboygan and in the Cheboygan River at that town, and in the Saginaw River. At Cheboygan they are caught principally in trap nets during the spring, usually in May, while in the Saginaw River they are caught in fyke nets and pound nets from November 1 to April 15. About one-half of the entire catch of the lake is salted and the remainder sold fresh. Suckers average in weight from 1¼ to 2 pounds each.

Yellow perch ordinarily bring a small price, an average being from ¾ to 1½ cents per pound. Along the Saginaw River, however, during the winter they are shipped to New York City by the fishermen and net them from 2 to 9 cents per pound. They are taken mainly in fyke nets, pound nets, and trap nets, and are all sold fresh. Perch vary in weight from 6 to 11 ounces each on an average.

With the exception of sturgeon, white-fish are the most valued of the commercial species taken in Lake Huron. They are caught in every county bordering on the lake, but are most plentiful around Little Charity Island, near the entrance to Saginaw Bay. This island is the property of a fishing firm at Bay City which supports a very extensive fishery there. White-fish are sold fresh except at times during the summer, when the flesh becomes soft from the extreme heat. The fish thus affected are salted before being marketed. In this process it is customary to open them down the back, as they do not keep well if opened down the belly. Practically the entire catch of white-fish is taken in pound nets and gill nets, the catch with the latter being principally by steamers. The average weight of white-fish taken in Lake Huron is from 2 to 3 pounds each. Off Caseville they are frequently taken weighing 17 pounds each, and one was taken in the fall of 1903 weighing 19 pounds. Those weighing 5 pounds or more are called jumbos and sell for double the price of the smaller ones.

Among the other species taken in this lake that assume some importance in certain localities are pike and pickerel, Menominee white-fish, rock bass, cat-fish, long-jaw white-fish, bullheads, and sturgeon. A few other species are also taken incidentally along the lake, but are of less importance.

Except on the Saginaw River very few fishermen along Lake Huron ship their own catch, but sell to local dealers. At West Bay City and Essexville there are five dealers who handle practically all of the fish

taken in Saginaw Bay west of Sebewaing, and also many of those taken as far north as Alpena, as has already been stated.

Saginaw River.—The fisheries of Saginaw River are prosecuted from its mouth to a short distance above Saginaw from November 1 to April 15. The greater part of the fishing is done through the ice. Several species are caught, the most important of which are suckers, yellow perch, wall-eyed pike, and pike. The catch is taken chiefly with fyke nets and pound nets, the latter being used with more profit during the fall before the ice forms. The depths in which fishing is carried on varies from 3 feet in the upper part of the river to 22 feet near the mouth.

In most cases the fishermen on the Saginaw River ship their own catch, the greater part of it going to New York City. A few of the dealers in that city have buyers, who go up and down the river buying fish directly from the fishermen. The fishermen who ship their own catch have live-cars, or large boxes, in which to keep the fish alive until ready for shipment. They can thus take advantage of good markets, and are to some degree independent of the dealers. The live-cars in common use on the river are 16 feet long, 5 to 8 feet wide and deep, and are divided by one or more partitions. Some of the fishermen have an apartment in their cars for each of the principal species. This arrangement saves assorting them when shipments are made. The cars are usually built of 1-inch white pine, and occasionally of hemlock, from 500 to 700 feet of lumber being required for a car. White pine is much preferred on account of not getting water-soaked quickly. The cars will last from four to thirteen years, according to the care taken of them. It is customary to take the cars ashore and clean and dry them about once every two years.

The following tables show by counties the extent of the fisheries of Lake Huron in 1903:

Table showing by counties the number of persons employed in the fisheries of Lake Huron in 1903.

County.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
Alcona			11		11
Alpena	21	3	83	30	137
Arenac			82		82
Bay		10	600	61	671
Cheboygan	6		76	21	103
Chippewa			39	6	45
Huron	6		174	23	203
Iosco	13		122	11	146
Mackinac			107		107
Presque Isle	5		14		19
Saginaw			75	5	80
St. Clair		3	16	30	49
Sanilac			33		33
Tuscola			18		18
Total	51	16	1,450	187	1,704

Table showing by counties the apparatus and capital employed in the fisheries of Lake Huron in 1903.

Item.	Alcona.		Alpena.		Arenac.		Bay.		Cheboygan.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			3	$9,000					1	$3,000
Tonnage			55						9	
Outfit				4,950						1,500
Vessels transporting			1	5,000			5	$14,700		
Tonnage			7				40			
Outfit				250				1,550		
Boats[a]	9	$525	43	3,410	32	$1,315	147	9,685	29	2,810
Gasoline launches					1	1,500	6	6,400	1	800
Apparatus—vessel fisheries:										
Gill nets			740	9,900					300	3,600
Apparatus—shore fisheries:										
Seines					5	285	6	120	3	60
Gill nets	5	25	353	2,665	16	48			306	1,720
Pound nets	12	2,450	82	19,500	73	11,170	310	39,485	8	1,045
Trap nets	25	625	30	850	30	845	250	7,285	95	4,685
Fyke nets					6	150	167	4,628		
Dip nets									10	5
Lines								18		3
Spears							400	1,200	3	4
Shore and accessory property		885		40,150		5,885		160,495		8,600
Cash capital				20,000				33,000		8,000
Total		4,460		115,675		21,228		278,566		35,832

Item.	Chippewa.		Huron.		Iosco.		Mackinac.		Presque Isle.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing			1	$2,000	2	$8,000			1	$2,000
Tonnage			20		35				10	
Outfit				645		2,800				900
Boats[a]	36	$2,930	92	12,875	55	4,660	43	$3,833	7	415
Gasoline launches	2	2,400	3	5,400			4	2,900		
Apparatus—vessel fisheries:										
Gill nets			250	2,000	720	6,945			212	3,180
Apparatus—shore fisheries:										
Seines			1	3	3	140				
Gill nets	410	3,338	1,085	6,934	814	5,964	199	870	67	425
Pound nets	16	2,145	225	43,315	85	16,135	31	5,325	5	625
Trap nets	136	2,840	50	1,345	14	350	95	2,675	6	240
Fyke nets			73	1,345			5	250		
Lines				96		46		20		
Spears							5	2		
Shore and accessory property		5,450		61,580		15,485		2,425		1,965
Cash capital		1,500		3,000						
Total		20,603		140,538		60,525		18,300		9,750

Item.	Saginaw.		St. Clair.		Sanilac.		Tuscola.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing									8	$24,000
Tonnage									129	
Outfit										10,795
Vessels transporting			1	$2,000					7	21,700
Tonnage			12						59	
Outfit				400						2,200
Boats[a]	69	$735	12	655	20	$945	12	$350	606	45,173
Gasoline launches			1	300	4	2,850			22	22,550
Apparatus—vessel fisheries:										
Gill nets									[b]2,222	25,625
Apparatus—shore fisheries:										
Seines									18	608
Gill nets			129	540	394	2,832	129	540	[b]3,907	25,901
Pound nets	28	1,030	28	5,500	24	4,425	21	2,575	951	154,725
Trap nets							3	30	734	21,770
Fyke nets	192	6,210							443	12,588
Dip nets									10	5
Lines										183
Spears									408	1,206
Shore and accessory property		37,495		34,125		10,300		2,325		387,115
Cash capital		5,000		25,000						95,500
Total		50,470		68,520		21,352		5,820		851,639

[a] Includes 5 steam tugs under 5 net tons, valued at $4,600.
[b] Total length, 550,515 yards in the vessel fisheries and 585,755 yards in the shore fisheries.

Table showing by counties the products of the fisheries of Lake Huron in 1903.

Species.	Alcona.		Alpena.		Arenac.		Bay.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cat-fish and bullheads	60	$1	401	$9	19,073	$648	105,962	$3,716
Dog-fish							5,211	83
Eels			94	3	24	1	895	35
Fresh-water drum					100	1	2,661	29
German carp	100	1	88	1	600	7	9,140	325
Herring, fresh	3,404	80	142,853	2,549	128,200	1,352	195,763	1,962
Herring, salted	60,490	1,125	153,985	2,959	484,265	9,005	257,140	5,103
Pike and pickerel, fresh	333	13	85	4	13,168	657	38,234	2,507
Pike and pickerel, salted					1,610	30		
Pike perch (wall-eyed pike)	39,337	1,797	169,769	11,368	120,692	6,695	653,774	36,003
Rock bass			50	1	9,897	222	49,093	1,581
Sturgeon	210	10	4,686	212	143	9	371	18
Suckers, fresh	14,100	230	65,766	1,192	102,360	1,348	517,094	13,608
Suckers, salted	42,090	732	91,195	1,666	4,485	81	27,715	516
Sun-fish					700	12	10,777	305
Trout, fresh	440	26	634,588	31,644	860	42	3,233	135
Trout, salted			3,450	124				
White-fish, fresh	10,100	698	117,551	7,202	54,776	3,388	87,208	5,554
White-fish, salted			2,415	73	9,315	283	19,435	678
White-fish (longjaw)			69,000	2,478				
White-fish (Menominee), fresh	1,900	67	40,207	1,372	595	17	2,192	67
White-fish (Menominee), salted	115	3	920	24				
Yellow perch	5,265	94	24,036	645	135,740	2,705	1,079,802	24,312
Total	177,944	4,877	1,521,139	63,526	1,086,603	26,503	3,065,700	96,537

Species.	Cheboygan.		Chippewa.		Huron.		Iosco.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cat-fish and bullheads			10,200	$297	10,238	$417	2,677	$88
Eels					62	4	16	1
Fresh-water drum					6,831	84		
German carp					3,948	75	200	2
Herring, fresh	4,200	$42			91,223	1,147	140,742	1,942
Herring, salted	6,465	129			1,616,045	32,004	727,490	13,656
Herring, smoked					640	40		
Ling or lawyers					80	2		
Muskellunge			420	24				
Pike and pickerel, fresh	115	4	47,850	1,182	801	38	349	14
Pike perch (wall-eyed pike)	11,000	974	44,300	2,027	327,077	17,737	84,932	5,119
Rock bass					636	10	129	5
Sturgeon	130	7	1,340	76	4,691	302	1,760	95
Sturgeon, caviar					46	31		
Suckers, fresh	405,000	6,960	24,000	160	86,236	1,471	60,570	1,275
Suckers, salted	231,801	5,885	109,480	2,104	1,035	18	16,100	312
Sun-fish			6,200	48				
Trout, fresh	186,400	9,071	185,800	7,603	255,150	11,547	480,908	22,871
Trout, salted	2,787	124					10,695	330
White-fish, fresh	28,315	1,806	35,170	1,784	112,858	8,324	111,808	6,798
White-fish, salted	2,431	127			155	13	4,350	153
White-fish, caviar					400	46		
White-fish (Menominee), fresh	24,430	652			10,261	377	20,662	796
White-fish (Menominee), salted	23,820	1,159						
Yellow perch	10,937	584	18,450	234	264,897	6,607	90,653	2,141
Total	937,861	27,024	483,210	15,539	2,793,310	80,294	1,754,056	55,598

Table showing by counties the products of the fisheries of Lake Huron in 1903—Continued.

Species.	Mackinac.		Presque Isle.		Saginaw.		St. Clair.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cat-fish and bullheads					5,919	$217	85	$3
Dog-fish					10,980	214		
Eels					120	14		
Fresh-water drum							36,850	185
German carp					15,715	481	6,100	39
Herring, fresh	28,750	$345	6,100	$160			175,230	1,815
Herring, salted	920	20	500	12				
Pike and pickerel, fresh	9,000	290			35,472	2,271		
Pike perch (wall-eyed pike)	19,240	1,036	1,267	88	17,826	1,294	61,713	3,339
Rock bass					50,770	1,417		
Sturgeon	5,920	308					13,440	1,041
Sturgeon, caviar							250	210
Suckers, fresh	220,970	3,678	300	3	525,121	18,611	19,230	176
Suckers, salted	58,075	1,262	46,600	810				
Sun-fish					24,805	701		
Trout, fresh	152,950	7,594	145,700	6,678			800	35
Trout, salted			1,600	48				
White-fish, fresh	68,324	3,655	18,000	899			860	50
White-fish (longjaw)			5,400	194				
White-fish (Menominee), fresh							5,500	225
White-fish (Menominee), salted			3,900	135				
Yellow perch	45,400	701	75	3	166,920	4,876	24,541	724
Total	609,549	18,909	229,442	9,030	853,648	30,096	344,799	7,842

Species.	Sanilac.		Tuscola.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Cat-fish and bullheads			1,211	$48	155,826	$5,444
Dog-fish					16,191	297
Eels					1,211	58
Fresh-water drum			984	10	47,426	309
German carp	200	$4	1,300	19	37,491	954
Herring, fresh	209,400	2,977	18,229	190	1,144,094	14,561
Herring, salted	184,218	4,009	4,715	119	3,496,233	68,141
Herring, smoked					640	40
Ling or lawyers					80	2
Muskellunge					420	24
Pike and pickerel, fresh					145,407	6,980
Pike and pickerel, salted					1,610	30
Pike perch (wall-eyed pike)	15,188	863	32,559	1,632	1,598,674	89,992
Rock bass					110,575	3,236
Sturgeon	1,125	73	211	11	34,047	2,162
Sturgeon, caviar					296	241
Suckers, fresh	1,000	10	19,731	252	2,061,578	48,974
Suckers, salted					628,576	12,886
Sun-fish					42,482	1,066
Trout, fresh	40,056	2,140			2,086,880	99,386
Trout, salted	3,220	112			21,752	738
White-fish, fresh	8,260	450	1,102	71	654,362	40,679
White-fish, salted					38,101	1,327
White-fish, caviar					400	46
White-fish (longjaw)					74,400	2,672
White-fish (Menominee), fresh	10,953	353			116,700	3,926
White-fish (Menominee), salted					28,755	1,321
Yellow perch	30,297	969	13,989	231	1,911,002	44,826
Total	503,917	11,960	94,031	2,583	14,455,209	450,318

Table showing by counties and apparatus the products of the vessel fisheries of Lake Huron in 1903.

Apparatus and species.	Alpena.		Cheboygan.		Huron.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:						
Pike perch (wall-eyed pike)	2,300	$247				
Trout, fresh	592,500	29,842	161,000	$8,100	120,000	$5,500
White-fish	60,000	4,202	19,000	1,300	225	11
White-fish (longjaw)	69,000	2,478				
White-fish (Menominee)	19,000	670				
Yellow perch	175	7				
Total	742,975	37,446	180,000	9,400	120,225	5,511

Apparatus and species.	Iosco.		Presque Isle.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:						
Herring	200	$3			200	$3
Pike perch (wall-eyed pike)	6,340	545	350	$23	8,990	815
Suckers	2,900	56			2,900	56
Trout, fresh	325,700	15,900	132,000	6,050	1,331,200	65,392
Trout, salted			1,600	48	1,600	48
White-fish	36,000	1,790	4,700	224	119,925	7,527
White-fish (longjaw)			5,400	194	74,400	2,672
White-fish (Menominee)	5,600	237			24,600	907
Yellow perch	65	2	75	3	315	12
Total	376,805	18,533	144,125	6,542	1,564,130	77,432

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Cat-fish and bullheads	60	$1	290	$6	6,435	$209	54,522	$1,822
Dog-fish							2,930	37
Eels			70	2			463	20
Fresh-water drum					100	1	2,161	24
German carp					100	1	3,519	135
Herring, fresh	404	5	125,403	2,203	127,900	1,349	192,563	1,927
Herring, salted	60,490	1,125	141,565	2,756	484,035	9,000	247,480	4,925
Pike and pickerel, fresh	245	9			1,758	87	15,391	921
Pike and pickerel, salted					805	15		
Pike perch (wall-eyed pike)	39,137	1,788	166,122	11,075	94,205	5,088	493,491	27,069
Rock bass					4,304	114	18,893	587
Sturgeon	210	10	4,199	194	143	9	196	9
Suckers, fresh	11,700	182	42,155	688	26,480	465	280,043	6,648
Suckers, salted	7,590	132	48,645	931	3,335	61	4,255	91
Sun-fish					100	2	4,468	114
Trout, fresh	440	26	21,588	987	860	42	3,209	134
White-fish, fresh	10,100	698	49,650	2,609	53,536	3,313	86,019	5,482
White-fish, salted			1,725	46	9,315	283	19,435	678
White-fish (Menominee), fresh	1,900	67	3,200	90	530	15	2,171	66
White-fish (Menominee), salted	115	3	920	24				
Yellow perch	4,665	82	19,391	540	85,660	1,788	622,304	13,732
Total	137,056	4,128	624,923	22,151	899,601	21,842	2,053,513	64,421
Trap nets:								
Cat-fish and bullheads			36	2	2,253	78	25,709	851
Dog-fish							900	9
Eels			24	1	24	1	275	8
Fresh-water drum							500	5
German carp	100	1	88	1	150	2	1,806	40
Herring, fresh			1,000	15			3,200	35
Herring, salted			6,325	100			9,660	178
Pike and pickerel, fresh	88	4	25	1	1,955	98	3,642	176
Pike and pickerel, salted					805	15		
Pike perch (wall-eyed pike)	200	9	75	4	3,666	211	87,445	4,601
Rock bass			50	1	2,233	42	4,325	94

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903—Continued.

Apparatus and species.	Alcona.		Alpena.		Arenac.		Bay.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Trap nets—Continued.								
Sturgeon			455	$17			175	$9
Suckers, fresh	2,400	$48	8,600	126	8,780	$120	87,838	1,381
Suckers, salted	34,500	600	38,410	677	920	15	23,460	425
Sun-fish					300	5	1,123	30
Trout							24	1
White-fish			176	12	605	37	1,129	68
White-fish (Menominee)			372	12	65	2	21	1
Yellow perch	600	12	4,265	92	20,230	373	260,843	4,886
Total	37,888	674	59,901	1,061	41,986	999	512,075	12,798
Gill nets:								
Cat-fish and bullheads			75	1	595	22		
Herring, fresh	3,000	75	16,450	331	300	3		
Herring, salted			6,095	103	230	5		
Pike and pickerel			60	3	1,380	69		
Pike perch (wall-eyed pike)			1,272	42	281	16		
Rock bass					530	11		
Sturgeon			32	1				
Suckers, fresh			15,011	378	2,750	40		
Suckers, salted			4,140	58				
Trout, fresh			20,500	815				
Trout, salted			3,450	124				
White-fish, fresh			7,725	379	555	33		
White-fish, salted			690	27				
White-fish (Menominee), fresh			17,635	600				
Yellow perch			205	6	5,910	113		
Total	3,000	75	93,340	2,868	12,531	312		
Fyke nets:								
Cat-fish and bullheads					7,830	280	23,106	938
Dog-fish							1,381	37
Eels							157	7
German carp					100	1	3,815	150
Pike and pickerel					1,220	60	18,881	1,394
Pike perch (wall-eyed pike)					200	12	6,843	396
Rock bass					2,500	50	25,875	900
Suckers, fresh					6,350	93	147,338	5,562
Suckers, salted					230	5		
Sun-fish							5,186	161
White fish					80	5	60	4
Yellow perch					13,400	267	192,255	5,593
Total					31,910	773	424,897	15,142
Seines:								
Cat-fish and bullheads					1,960	59		
German carp					250	3		
Pike and pickerel					6,855	343		
Pike perch (wall-eyed pike)					22,340	1,368	1,355	81
Rock bass					330	5		
Suckers, fresh					58,000	630	1,875	17
Sun-fish					300	5		
Yellow perch					10,540	164		
Total					100,575	2,577	3,230	98
Lines:								
Cat-fish and bullheads							2,625	105
Pike perch (wall-eyed pike)							140	8
Total							2,765	113
Spears:								
Pike and pickerel							320	16
Pike perch (wall-eyed pike)							64,500	3,848
Yellow perch							4,400	101
Total							69,220	3,965
Grand total	177,944	4,877	778,164	26,080	1,086,603	26,503	3,065,700	96,587

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903—Continued.

Apparatus and species.	Cheboygan.		Chippewa.		Huron.		Iosco.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Cat-fish and bullheads			2,400	$72	6,208	$253	2,336	$75
Eels					33	2	16	1
Fresh-water drum					5,535	66		
German carp					1,280	34	200	2
Herring, fresh	4,200	$42			81,923	1,010	136,725	1,877
Herring, salted	2,200	44			1,616,045	32,004	723,925	13,588
Herring, smoked					640	40		
Ling or lawyers					80	2		
Pike and pickerel, fresh	90	3	5,400	142	22	1	122	4
Pike perch (wall-eyed pike)	2,100	41	2,800	112	305,893	16,412	72,702	4,228
Rock bass							129	5
Sturgeon	130	7	820	44	4,691	302	1,780	95
Caviar					46	31		
Suckers, fresh			4,000	20	34,533	561	22,267	338
Suckers, salted	10,035	210	7,130	124	1,035	18	12,650	242
Trout, fresh	4,000	165	32,450	1,296	2,630	126	17,308	794
Trout, salted	977	42					7,705	235
White-fish, fresh	4,100	221	26,520	1,324	110,213	8,143	48,611	3,404
White-fish, salted	131	7			155	13	3,430	115
White-fish caviar					400	46		
White-fish (Menominee), fresh					2,186	91	7,526	274
White-fish (Menominee), salted	120	4						
Yellow perch			1,950	22	131,518	3,138	27,006	517
Total	28,083	792	83,470	3,156	2,305,066	62,323	1,084,438	25,794
Trap nets:								
Cat-fish and bullheads			7,800	225	2,372	115	291	12
Eels					29	2		
Fresh-water drum					1,296	18		
German carp					300	6		
Herring, fresh					700	22		
Herring, salted	4,265	85						
Muskellunge			420	24				
Pike and pickerel, fresh			42,450	1,040	45	2	144	7
Pike perch (wall-eyed pike)	6,800	892	41,500	1,915	9,925	667	500	28
Rock bass					480	8		
Sturgeon			520	32				
Suckers, fresh	325,000	6,255	20,000	140	31,606	621	523	7
Suckers, salted	210,260	4,903	102,350	1,980				
Sun-fish			6,200	48				
Trout			4,600	167				
White-fish					120	10		
White-fish (Menominee)					350	21		
Yellow perch	10,700	577	16,500	212	45,705	1,387	38,162	728
Total	557,025	12,712	242,340	5,783	92,928	2,879	39,620	782
Gill nets:								
Cat-fish and bullheads							50	1
Herring, fresh					8,600	85	3,817	62
Herring, salted							3,565	68
Pike and pickerel	25	1					83	3
Pike perch (wall-eyed pike)	2,100	41			10,652	625	5,390	318
Suckers, fresh	1,000	15			1,470	13	28,050	651
Suckers, salted	3,481	86					2,760	58
Trout, fresh	20,200	756	148,750	6,140	129,120	5,676	136,095	6,092
Trout, salted	1,810	82					2,990	95
White-fish, fresh	5,245	285	8,650	460	2,300	160	24,097	1,446
White-fish, salted	2,300	120					920	38
White-fish (Menominee), fresh	24,430	652			7,725	265	7,536	285
White-fish (Menominee), salted	23,700	1,155						
Yellow perch	237	7			18,700	506	25,420	894
Total	84,528	3,200	157,400	6,600	178,567	7,330	240,773	10,014
Fyke nets:								
Cat-fish and bullheads					1,658	49		
German carp					488	9		
Pike and pickerel					734	35		
Pike perch (wall-eyed pike)					607	33		

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903—Continued.

Apparatus and species.	Cheboygan.		Chippewa.		Huron.		Iosco.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fyke nets—Continued.								
Rock bass					156	$2		
Suckers, fresh					18,627	276		
Yellow perch					51,471	1,010		
Total					73,741	1,414		
Seines:								
German carp					1,880	26		
Suckers, fresh	39,000	$500					6,830	$220
Suckers, salted	3,400	75					690	12
White-fish							3,100	158
Total	42,400	575			1,880	26	10,620	390
Lines:								
Trout	1,200	50			3,400	245	1,800	85
Yellow perch					17,500	566		
Total	1,200	50			20,900	811	1,800	85
Spears:								
Suckers, salted	4,625	105						
Dip nets:								
Suckers	40,000	190						
Grand total	757,861	17,624	483,210	$15,539	2,673,085	74,783	1,377,251	37,065

Apparatus and species.	Mackinac.		Presque Isle.		Saginaw.		St. Clair.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Cat-fish and bullheads					770	$36	85	$3
Dog-fish					925	21		
Fresh-water drum							36,850	185
German carp					682	23	6,200	39
Herring, fresh	28,750	$345					174,730	1,810
Herring, salted	920	20						
Pike and pickerel, fresh					3,627	293		
Pike perch (wall-eyed pike)	350	20	900	$64	9,166	666	61,713	3,339
Rock bass					7,720	241		
Sturgeon	5,920	308					13,440	1,041
Sturgeon caviar							250	210
Suckers, fresh	3,500	48			63,111	2,534	19,330	176
Suckers, salted	29,325	637						
Sun-fish					3,495	113		
Trout, fresh	80,578	4,233	9,600	400			800	35
White-fish, fresh	60,829	3,280	12,000	600			860	50
White-fish (Menominee), fresh							1,000	40
Yellow perch	2,100	85			29,050	1,186	8,041	240
Total	212,272	8,926	22,500	1,064	118,546	5,113	323,299	7,168
Trap nets:								
Pike and pickerel, fresh	9,000	290						
Pike perch (wall-eyed pike)	18,640	1,022						
Suckers, fresh	217,470	3,630	300	3				
Suckers, salted			46,000	800				
Yellow perch	43,300	666						
Total	288,410	5,608	46,300	803				
Gill nets:								
Herring, fresh			6,100	160			500	5
Herring, salted			500	12				
Pike perch (wall-eyed pike)			17	1				
Suckers, salted			600	10				
Trout, fresh	46,680	2,070	4,100	228				
White-fish, fresh	7,495	375	1,300	75				
White-fish (Menominee), fresh							4,500	185
White-fish (Menominee), salted			3,900	135				
Yellow perch							16,500	844
Total	54,175	2,445	16,517	621			21,500	674

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903—Continued.

Apparatus and species.	Mackinac.		Presque Isle.		Saginaw.		St. Clair.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fyke nets:								
Cat-fish and bullheads					5,149	$181		
Dog-fish					10,055	193		
Eels					120	14		
German carp					15,033	458		
Pike and pickerel					31,845	1,978		
Pike perch (wall-eyed pike)	250	$14			8,660	628		
Rock bass					43,050	1,176		
Suckers, fresh					462,010	16,077		
Suckers, salted	28,750	625						
Sun-fish					21,310	588		
Yellow perch					137,870	3,690		
Total	29,000	639			735,102	24,983		
Lines:								
Trout	25,132	1,257						
Spears:								
Trout	560	34						
Grand total	609,549	18,909	85,317	$2,488	853,648	30,096	344,799	$7,842

Apparatus and species.	Sanilac.		Tuscola.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:						
Cat-fish and bullheads			1,211	$48	74,317	$2,525
Dog-fish					3,855	58
Eels					582	25
Fresh-water drum			984	10	45,630	286
German carp	200	$4	1,300	19	13,481	257
Herring, fresh	195,200	2,817	18,229	190	1,086,027	13,605
Herring, salted	181,918	3,969	4,715	119	3,463,293	67,550
Herring, smoked					640	40
Ling or lawyers					80	2
Pike and pickerel, fresh					26,655	1,460
Pike and pickerel, salted					805	15
Pike perch (wall-eyed pike)	15,188	863	32,459	1,626	1,296,226	72,391
Rock bass					31,046	947
Sturgeon	1,125	73	211	11	32,865	2,103
Sturgeon caviar					296	241
Suckers, fresh	1,000	10	19,231	246	527,350	11,916
Suckers, salted					124,000	2,452
Sun-fish					8,063	229
Trout, fresh	3,961	201			177,424	8,439
Trout, salted					8,682	277
White-fish, fresh	7,660	416	1,102	71	471,200	29,611
White-fish, salted					34,191	1,142
White-fish caviar					400	46
White-fish (Menominee), fresh					18,513	643
White-fish (Menominee), salted					1,155	31
Yellow perch	100	4	13,389	222	945,174	21,506
Total	406,352	8,357	92,831	2,562	8,391,950	237,797
Trap nets:						
Cat-fish and bullheads					38,461	1,283
Dog-fish					900	9
Eels					352	12
Fresh-water drum					1,796	23
German carp					2,444	50
Herring, fresh					4,900	72
Herring, salted					20,250	363
Muskellunge					420	24
Pike and pickerel, fresh					57,349	1,618
Pike and pickerel, salted					805	15
Pike perch (wall-eyed pike)			100	6	168,851	9,355
Rock bass					7,088	145
Sturgeon					1,150	58
Suckers, fresh			500	6	708,017	12,337
Suckers, salted					455,900	9,400
Sun-fish					7,623	88
Trout					4,624	163
White-fish					2,030	127

Table showing by counties and apparatus the products of the shore fisheries of Lake Huron in 1903—Continued.

Apparatus and species.	Sanilac.		Tuscola.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Trap nets—Continued.						
White-fish (Menominee)					808	$36
Yellow perch			600	$9	440,905	8,942
Total			1,200	21	1,919,673	44,120
Gill nets:						
Cat-fish and bullheads					720	24
Herring, fresh	14,200	$160			52,967	881
Herring, salted	2,300	40			12,690	228
Pike and pickerel					1,548	76
Pike perch (wall-eyed pike)					19,712	1,043
Rock bass					530	11
Sturgeon					32	1
Suckers, fresh					48,281	1,100
Suckers, salted					10,981	212
Trout, fresh	36,095	1,939			541,540	23,716
Trout, salted	3,220	112			11,470	413
White-fish, fresh	600	34			57,967	3,247
White-fish, salted					3,910	185
White-fish (Menominee), fresh	10,953	353			72,779	2,340
White-fish (Menominee), salted					27,600	1,290
Yellow perch	30,197	965			97,169	2,975
Total	97,565	3,603			959,896	37,742
Fyke nets:						
Cat-fish and bullheads					37,743	1,448
Dog-fish					11,436	230
Eels					277	21
German carp					19,436	618
Pike and pickerel					52,680	3,467
Pike perch (wall-eyed pike)					16,560	1,083
Rock bass					71,581	2,128
Suckers, fresh					631,325	22,008
Suckers, salted					28,980	630
Sun-fish					26,496	749
White-fish					140	9
Yellow perch					394,999	10,560
Total					1,294,653	42,951
Seins:						
Cat-fish and bullheads					1,960	59
German carp					2,130	29
Pike and pickerel					6,855	343
Pike perch (wall-eyed pike)					23,695	1,449
Rock bass					330	5
Suckers, fresh					105,705	1,367
Suckers, salted					4,090	87
Sun-fish					300	5
White-fish					3,100	158
Yellow perch					10,540	164
Total					158,705	3,666
Lines:						
Cat-fish and bullheads					2,625	105
Pike perch (wall-eyed pike)					140	8
Trout					31,532	1,637
Yellow perch					17,500	566
Total					51,797	2,316
Spears:						
Pike and pickerel					320	16
Pike perch (wall-eyed pike)					64,500	3,848
Suckers, salted					4,625	105
Trout					560	31
Yellow perch					4,400	101
Total					74,405	4,101
Dip nets:						
Suckers					40,000	190
Grand total	503,917	11,960	94,031	2,583	12,891,079	372,886

WHOLESALE FISHERY TRADE OF LAKE HURON.

Wholesale fishery establishments are located at several towns along Lake Huron, but by far the greater part of the catch is handled by five firms at West Bay City and Essexville. Since 1899 some of these firms have established new houses at Alpena, the existence of which has proved quite an incentive to the fishermen and has created an upward tendency in prices. The bulk of the fish handled by the wholesale dealers along the lake is caught in American waters, except at Port Huron, where the reverse is the case. Over three-fourths of the total quantity of sturgeon and caviar handled along the American side of Lake Huron was taken in Canadian waters. The many small bays and inlets of the Canadian side of the lake seem to be especially favorable for this and other species. In 1903 there were 16 establishments engaged in the wholesale fishery trade of Lake Huron. The persons engaged numbered 134; the wages paid amounted to $38,420; the cash capital was $95,500, and the value of the establishments, with their appurtenances, was $96,500. Since 1899 there has been an increase of 3 establishments, $39,205 in the value of property, $40,000 in the cash capital, $15,106 in the amount of wages paid, and 47 in the number of persons engaged.

Table showing the extent of the wholesale fishery trade of Lake Huron in 1903.

Item.	No.	Value.
Establishments	16	$96,500
Cash capital		95,500
Persons engaged	134	
Wages paid		38,420

Product.	Lbs.	Value.	Product.	Lbs.	Value.
Cat-fish and bullheads	109,120	$6,059	Suckers, fresh	1,543,877	$50,858
Dog-fish	2,855	88	Suckers, salted	898,093	25,880
Eels	610	37	Sun-fish	24,505	729
Fresh-water drum, fresh	68,659	956	Trout, fresh	1,013,136	64,400
Fresh-water drum, salted	920	19	Trout, salted	30,235	1,433
German carp	56,491	1,805	Trout, smoked	2,000	160
Herring, fresh	780,810	23,720	White-fish, fresh	824,520	63,079
Herring, salted	3,005,985	66,805	White-fish, salted	116,864	5,256
Herring, smoked	8,640	453	White-fish, smoked	40,033	3,604
Pike and pickerel, fresh	130,033	8,498	White-fish (Menominee), fresh	91,342	5,196
Pike and pickerel, salted	1,610	42	White-fish (Menominee), salted	80,155	4,397
Pike perch (wall-eyed), fresh	2,093,741	161,109	Yellow perch, fresh	1,717,301	68,040
Pike perch (wall-eyed), salted	345	12	Yellow perch, salted	100	5
Rock bass	72,833	3,101	Other fish	65,775	4,356
Sturgeon	120,577	13,475			
Sturgeon caviar	9,653	7,856	Total	12,910,821	591,423

NOTE.—Included in the above is 589,960 pounds of fish imported from Canada, valued at $50,146. Of this quantity sturgeon comprised 91,800 pounds and caviar 9,160 pounds, the combined value of which was $13,194.

FISHERIES OF LAKE ST. CLAIR AND ST. CLAIR AND DETROIT RIVERS.

The fisheries of Lake St. Clair and St. Clair and Detroit rivers in 1903 gave employment to 355 men, of whom 303 were engaged in the shore fisheries and 52 on shore and in fish houses. The total amount of capital invested was $239,885. The number of boats in use was 150, valued at $3,150. The apparatus of capture was valued at $1,851, the greater part of which represented the value of seines, spears, and lines. The shore and accessory property was valued at $141,805, and the cash capital employed amounted to $93,079.

While the catch by seines was the greatest, lines were used by the largest number of men, and spears ranked next in that particular. In the St. Clair River hand-line fishing was followed by 275 men, the catch being mostly wall-eyed pike. The season usually extends from May 1 to July 15, and occasionally in August, after a hard blow, some of the men fish for awhile. The methods of hand-line fishing consist of "trolling" and "chugging." In trolling two men usually go in a boat, one man rowing and the other handling the line. Occasionally, however, one man goes alone, in which case, while rowing the boat, he holds the line in his mouth by means of a piece of leather. One man always goes alone while chugging. The chugging line is used by being continually jerked up and down to attract the attention of the fish. A trolling line is from 75 to 100 feet long on an average, and a chugging line about 20 feet. The trolling outfit costs from 75 cents to $2, while the chugging line costs only from 50 to 75 cents. Besides wall-eyed pike, a few fresh-water drum and pike are taken on lines. Quite an important set-line fishery for sturgeon used to be conducted in the Detroit River south of Detroit during April and May. Fifteen years ago from 20 to 25 men made a profitable business of it, while in 1903 there were only 4 men, with the probability of some of them dropping out the following year.

An important seine fishery is located at Roberts Landing, on the St. Clair River, and another at Mount Clemens, on Lake St. Clair. The catch of the former is principally wall-eyed pike and suckers, while the catch of the latter consists wholly of German carp. A law was recently enacted by the Michigan legislature which allows in Lake St. Clair the use of seines with a 4-inch extension mesh, provided no other fish than carp is taken. To safeguard the enforcement of this law it is necessary for every fisherman to give a bond to the board of state fish commissioners before he is allowed to fish. As this act had just been passed only one firm took advantage of it in 1903. The most suitable time for this fishing is in the early spring. After being caught the carp are put into a receiving or storage pond and kept until prices advance. Two seine fisheries were conducted in the Detroit

River by a Detroit firm, which was allowed to sell the white-fish which had been stripped of eggs and milt by employees of the Bureau of Fisheries.

The use of spears through the ice was followed principally at Fairhaven. Several species were taken in this manner, the most important being pike. The catch was sold to local buyers, who acted as agents for firms in larger cities.

Wall-eyed pike constituted nearly three-fourths of the entire catch of these waters and were taken mainly on lines and in seines. White-fish and German carp ranked next, the former being taken exclusively in seines and the latter in seines and by spears.

Compared with the returns for 1903, those for 1899 show a decrease from 442 to 355 in the number of persons engaged. The investment has increased from $54,535 to $239,885, and the products have decreased from 579,067 pounds, valued at $23,864, to 521,941 pounds, valued at $21,594. The increase in the investment is due almost wholly to an extension of the wholesale trade.

The following tables show the extent of the fisheries of Lake St. Clair and the St. Clair and Detroit rivers in 1903:

Table showing by counties the number of persons employed in the fisheries of Lake St. Clair and the St. Clair and Detroit rivers in 1903.

County.	In shore fisheries.	On shore, in fish houses, etc.	Total.
St. Clair	252	7	259
Wayne	51	45	96
Total	303	52	355

Table showing by counties the apparatus and capital employed in the fisheries of Lake St. Clair and the St. Clair and Detroit rivers in 1903.

Item.	St. Clair.		Wayne.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Boats [a]	138	$1,930	12	$1,220	150	$3,150
Apparatus—shore fisheries:						
Seines	2	225	4	665	6	890
Lines		275		50		325
Spears	230	632			230	632
Dip nets	8	4			8	4
Shore and accessory property		7,755		134,050		141,805
Cash capital				93,079		93,079
Total		10,821		229,064		239,885

[a] Includes 1 steamboat, worth $800, in Wayne County.

Table showing by counties the yield of the fisheries of Lake St. Clair and the St. Clair and Detroit rivers in 1903.

Species.	St. Clair.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Buffalo-fish	800	$2			800	$2
Fresh-water drum	10,200	126			10,200	126
German carp	101,500	1,797	500	$15	102,000	1,812
Minnows	3,000	800			3,000	800
Muskellunge	3,000	405			3,000	405
Pike and pickerel	20,200	1,185			20,200	1,185
Pike perch (wall-eyed)	250,550	12,957	100	7	250,650	12,964
Rock bass	3,700	185			3,700	185
Sturgeon	175	16	8,550	553	8,725	569
Caviar	75	60			75	60
Suckers	82,600	1,018	300	9	82,900	1,027
Sun-fish	6,500	325			6,500	325
White-fish			25,591	1,904	25,591	1,904
Yellow perch	4,600	230			4,600	230
Total	486,900	19,106	35,041	2,488	521,941	21,594

Table showing by counties and apparatus of capture the yield of the fisheries of Lake St. Clair and the St. Clair and Detroit rivers in 1903.

Apparatus and species.	St. Clair.		Wayne.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines:						
Fresh-water drum	10,000	$125			10,000	$125
German carp	61,500	1,477	500	$15	62,000	1,492
Pike perch (wall-eyed)	91,000	5,000	100	7	91,100	5,007
Sturgeon	175	16	250	17	425	33
Caviar	75	60			75	60
Suckers	81,400	1,015	300	9	81,700	1,024
White-fish			25,591	1,904	25,591	1,904
Total	244,150	7,693	26,741	1,952	270,891	9,645
Lines:						
Fresh-water drum	200	1			200	1
Pike and pickerel	700	15			700	15
Pike perch (wall-eyed)	155,250	7,570			155,250	7,570
Sturgeon			8,300	536	8,300	536
Total	156,150	7,586	8,300	536	164,450	8,122
Miscellaneous apparatus:						
Buffalo-fish	800	2			800	2
German carp	40,000	320			40,000	320
Minnows	3,000	800			3,000	800
Muskellunge	3,000	405			3,000	405
Pike and pickerel	19,500	1,170			19,500	1,170
Pike perch (wall-eyed pike)	4,300	387			4,300	387
Rock bass	3,700	185			3,700	185
Suckers	1,200	3			1,200	3
Sun-fish	6,500	325			6,500	325
Yellow perch	4,600	230			4,600	230
Total	86,600	3,827			86,600	3,827
Grand total	486,900	19,106	35,041	2,488	521,941	21,594

WHOLESALE FISHERY TRADE OF LAKE ST. CLAIR AND ST. CLAIR AND DETROIT RIVERS.

The wholesale fishery trade of this region is centered at Detroit, where 5 firms were located in 1903. The greater part of the fish handled by these firms was caught in Canadian waters. There were 45 persons engaged in this branch of the trade and $30,717 were paid

in wages. The value of the 5 establishments was $131,700 and the cash capital employed $93,079.

The following table shows in detail the quantity and value of products handled in the wholesale fishery trade at Detroit:

Table showing the extent of the wholesale fishery trade of Lake St. Clair and St. Clair and Detroit rivers in 1903.

Item.	Wayne County. No.	Wayne County. Value.
Establishments	5	$131,700
Cash capital		93,079
Wages		30,717
Persons engaged	45	

Product.	Lbs.	Value.	Product.	Lbs.	Value.
Fresh:			Salted:		
Cat-fish and bullheads	101,272	$6,206	Herring	2,519,404	$111,068
Eels	17,941	1,159	Pike and pickerel	27,809	1,756
Fresh-water drum	188,000	4,700	Pike perch (wall-eyed)	3,286	216
German carp	63,869	2,107	Suckers	239,908	9,598
Herring	1,068,089	51,562	Trout	18,120	1,087
Pike and pickerel	208,948	13,829	White-fish	82,378	6,348
Pike perch (blue pike)	610,281	34,206	White-fish (bluefin)	9,050	366
Pike perch (wall-eyed)	597,395	45,308	Other fish	592	29
Pike perch (sauger)	30,000	1,500			
Rock bass and sun-fish	18,000	690	Total	2,900,547	130,468
Salt-water fish	88,946	5,998			
Sturgeon	27,931	2,919	Smoked:		
Sturgeon caviar	960	668	Herring	68,835	7,962
Suckers	137,404	5,058	Salt-water fish	23,551	1,266
Trout	1,100,184	72,204	Sturgeon	1,000	200
White bass	10,938	447	Trout	1,240	75
White-fish	1,617,216	129,374	White-fish	15,238	1,063
White-fish (bluefin and tullibee)	70,313	3,616	Total	109,864	10,569
White-fish (Menominee)	4,000	240			
Yellow perch	460,864	18,567	Grand total	9,444,793	542,911
Other fish	11,831	1,516			
Total	6,434,382	401,874			

FISHERIES OF LAKE ERIE.

The fisheries of Lake Erie in 1903 gave employment to 2,727 persons, of whom 633 were on vessels fishing and transporting, 1,591 on boats in the shore fisheries, and 503 were shoresmen in connection with the fisheries and the various fishery industries. Following is the number of persons credited to the different states bordering on this lake: New York, 1,017; Pennsylvania, 487; Ohio, 1,101; and Michigan, 122.

The total amount of capital invested in the fisheries of the lake was $2,196,397. This included 102 fishing and transporting vessels, of 1,859 net tons, valued at $378,650, with outfits valued at $62,428; 467 boats, valued at $22,208; 39 gasoline launches under 5 tons, valued at $26,950; fishing apparatus used on vessels and boats to the value of $379,776; shore and accessory property in the fisheries and wholesale fishery trade, valued at $919,635; and cash capital utilized in the fishery industries, amounting to $406,750. The investment in New

York was $470,606; in Pennsylvania, $495,959; in Ohio, $1,205,002; and in Michigan, $24,830.

The products of the fisheries aggregated 23,188,556 pounds, for which the fishermen received $780,015. Of this quantity, 12,448,089 pounds, valued at $468,821, was taken by vessels, and 10,740,467 pounds, valued at $311,194, by boats. The yield in New York was 2,949,305 pounds, valued at $128,445; in Pennsylvania, 8,367,707 pounds, valued at $305,244; in Ohio, 10,748,986 pounds, valued at $317,027; and in Michigan, 1,122,558 pounds, valued at $29,299. In the vessel fisheries the products were all taken with gill nets, except 27,000 pounds of turtles, valued at $1,620, which were caught in turtle nets. In the shore fisheries, pound nets took 4,471,824 pounds, valued at $142,272; trap nets, 1,365,596 pounds, valued at $32,004; fyke nets, 959,987 pounds, valued at $18,239; gill nets, 937,733 pounds, valued at $49,097; seines, 2,633,267 pounds, valued at $45,724; lines, 341,260 pounds, valued at $22,986; and other forms of apparatus, 30,800 pounds, valued at $872. The species taken in largest quantities were herring, 8,788,625 pounds, $333,844; blue pike, 4,915,357 pounds, $188,033; German carp, 3,546,752 pounds, $59,198; sauger, 1,940,355 pounds, $47,697; wall-eyed pike, 908,484 pounds, $49,462; yellow perch, 830,403 pounds, $27,001; suckers, 721,089 pounds, $8,695; fresh-water drum, 642,445 pounds, $4,513; white-fish, 302,805 pounds, $22,988; and sturgeon, including caviar, 300,103 pounds, $26,480. About 93 per cent of the herring and 64 per cent of the blue pike were taken by vessels, the two species forming over 90 per cent of the products of the vessel fisheries. Yellow perch and saugers were also caught in large quantities by vessels. The German carp, except 270 pounds, valued at $2, were taken in the boat fisheries.

The fisheries of Lake Erie in 1903 were less extensive than in any of the recent years (1890, 1893, or 1899), for which statistics are available. Comparing the returns with those for 1899, the year for which the last canvass was made, there has been a decrease of 1,001, or 27 per cent, in the number of persons employed; $524,157, or 19 per cent, in the investment; 35,205,308 pounds, or 60 per cent, in the quantity, and $370,880, or 32 per cent, in the value of the products. The decrease in products was principally in herring, but there was also a large decline in the catch of cat-fish and bullheads, black bass, fresh-water drum, wall-eyed pike, sauger, white bass, white-fish, yellow perch, and various other species. The only important species in which there was an increase is blue pike.

The following tables give, by states and counties, the number of persons employed, the amount of capital invested, and the quantity and value of the products of the fisheries of Lake Erie in 1903:

Table showing by states and counties the number of persons employed in the fisheries of Lake Erie in 1903.

State and county.	On vessels fishing.	On vessels transporting.	In shore or boat fisheries.	Shoresmen.	Total.
New York:					
Erie	96		671	116	883
Chautauqua	36		73	25	134
Total	132		744	141	1,017
Pennsylvania:					
Erie	276		76	135	487
Ohio:					
Ashtabula			2		2
Lake			7		7
Cuyahoga	149		39	130	318
Lorain			33	15	48
Erie	40	12	78	46	176
Sandusky			16		16
Ottawa			362	24	386
Lucas	24		112	12	148
Total	213	12	649	227	1,101
Michigan:					
Monroe			122		122
Grand total	621	12	1,591	503	2,727

Table showing by states and counties the vessels, boats, apparatus, and capital employed in the fisheries of Lake Erie in 1903.

State and county.	Vessels fishing.				Vessels transporting.				Boats.		Gasoline boats.	
	No.	Tonnage.	Value.	Value of outfit.	No.	Tonnage.	Value.	Value of outfit.	No.	Value.	No.	Value.
New York:												
Erie	16	334	$61,200	$9,700					35	$1,445	5	$3,500
Chautauqua	6	82	11,900	3,115					17	880	13	8,850
Total	22	416	73,100	12,815					52	2,325	18	12,350
Pennsylvania:												
Erie	44	698	168,500	25,214					47	2,135	6	6,400
Ohio:												
Ashtabula									1	25		
Lake									9	690		
Cuyahoga	24	409	83,600	15,724					12	1,000		
Lorain									5	336	2	1,100
Erie	6	150	17,450	2,675	2	126	$25,000	$4,500	42	2,100	1	350
Sandusky									12	775		
Ottawa									168	9,632	9	5,400
Lucas	4	60	11,000	1,500					55	1,365	1	500
Total	34	619	112,050	19,899	2	126	25,000	4,500	304	15,923	13	7,350
Michigan:												
Monroe									64	1,825	2	850
Grand total	100	1,733	353,650	57,928	2	126	25,000	4,500	467	22,208	39	26,950

Table showing by states and counties the vessels, boats, apparatus, and capital employed in the fisheries of Lake Erie in 1903—Continued.

State and county.	Vessel fisheries.				Apparatus of capture, shore fisheries.							
	Gill nets.		Turtle nets.		Gill nets.		Pound nets.		Trap nets.		Fyke nets.	
	No.	Value.	No.	Val.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
New York:												
Erie	4,311	$22,175	...	...	859	$4,548	...	...	...	...	...	...
Chautauqua	2,056	10,600	...	...	2,479	22,422	9	$2,550	14	$1,350	...	...
Total	6,367	32,775	...	...	3,338	26,970	9	2,550	14	1,350	...	...
Pennsylvania:												
Erie	12,432	62,160	...	...	1,464	6,828	49	18,300	67	2,005	...	...
Ohio:												
Ashtabula	...	...	...	...	15	15	...	...	...	...	...	...
Lake	...	...	...	...	...	...	29	5,900	...	...	...	...
Cuyahoga	7,236	36,380	...	...	...	...	81	26,300	...	...	...	...
Lorain	...	...	...	...	...	...	43	16,400	...	...	10	$500
Erie	1,520	7,000	70	$210	520	1,355	60	14,200	75	1,910	48	1,630
Sandusky	...	...	...	...	65	300	...	...	...	...	26	600
Ottawa	...	...	...	...	994	1,998	170	38,300	373	19,845	176	12,180
Lucas	1,200	4,800	...	...	...	...	137	8,060	20	800	19	750
Total	9,956	48,180	70	210	1,594	3,668	520	109,160	468	22,555	279	15,660
Michigan:												
Monroe	...	...	...	...	...	...	236	15,960	106	925	28	830
Grand total	28,755	143,115	70	210	6,396	37,466	814	145,970	655	26,835	307	16,490

State and county.	Apparatus of capture, shore fisheries.				Value of minor apparatus.	Value of lines.	Shore and accessory property.	Cash capital.	Total investment.
	Seines.		Turtle nets.						
	No.	Value.	No.	Value.					
New York:									
Erie	...	...	...	...	...	$970	$128,420	$135,250	$367,208
Chautauqua	...	...	...	...	...	221	19,510	22,000	103,398
Total	...	...	...	...	...	1,191	147,930	157,250	470,606
Pennsylvania:									
Erie	...	...	...	...	...	117	140,300	64,000	495,959
Ohio:									
Ashtabula	...	...	...	...	...	20	...	...	60
Lake	...	...	...	...	...	...	4,050	...	10,640
Cuyahoga	...	...	...	...	...	...	344,100	88,500	595,604
Lorain	...	...	...	...	$3	5	11,700	5,000	35,044
Erie	4	$460	...	...	...	5	136,965	57,000	272,810
Sandusky	2	150	...	...	...	...	...	...	1,825
Ottawa	52	3,935	135	$270	...	19	66,690	20,000	178,269
Lucas	32	2,050	...	...	...	...	64,925	15,000	110,750
Total	90	6,595	135	270	3	49	628,430	185,500	1,205,002
Michigan:									
Monroe	20	1,445	...	...	...	20	2,975	...	24,830
Grand total	110	8,040	135	270	3	1,377	919,635	406,750	2,196,397

Tables showing by states, counties, and species the yield of the fisheries of Lake Erie in 1903.

State and county.	Black bass.		Cat-fish and bull-heads.		Dog-fish or bow-fin.		Fresh-water drum.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	....	....	2,271	$90	....	....	....	....
Chautauqua	4,825	$387	300	18	....	....	800	$12
Total	4,825	387	2,571	108	....	....	800	12
Pennsylvania:								
Erie	....	....	12,315	724	....	....	60,061	838
Ohio:								
Ashtabula	....	....	1,000	50	....	....	....	....
Lake	....	....	7,662	346	....	....	23,612	187
Cuyahoga	....	....	900	38	....	....	7,914	77
Lorain	....	....	2,000	80	....	....	24,000	120
Erie	....	....	12,391	528	....	....	42,752	356
Sandusky	....	....	2,583	104	....	....	....	....
Ottawa	....	....	106,364	4,143	....	....	280,030	1,836
Lucas	....	....	12,265	491	....	....	63,530	372
Total	....	....	145,165	5,780	....	....	441,838	2,948
Michigan:								
Monroe	....	....	21,724	859	1,062	$6	139,746	715
Grand total	4,825	387	181,775	7,471	1,062	6	642,445	4,513

State and county.	German carp.		Herring.		Ling or lawyer.		Pike perch (blue pike.)	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	2,560	$45	906,172	$36,189	....	....	544,029	$23,207
Chautauqua	19,000	372	599,152	22,043	....	....	459,318	16,931
Total	21,560	417	1,505,324	58,232	....	....	1,003,347	40,138
Pennsylvania:								
Erie	29,650	451	5,750,352	207,763	....	....	2,179,039	79,465
Ohio:								
Lake	18,350	233	3,744	129	1,140	$23	167,202	4,803
Cuyahoga	11,712	273	1,094,071	49,129	12,210	75	1,116,293	45,923
Lorain	31,616	460	28,256	1,412	....	....	244,046	11,103
Erie	233,210	4,068	187,759	8,354	....	....	177,130	5,582
Sandusky	108,658	1,607	....	....	....	....	....	....
Ottawa	2,434,304	41,851	6,807	345	343	1	11,841	443
Lucas	220,357	2,203	210,230	8,408	....	....	16,459	576
Total	3,058,207	50,695	1,530,867	67,777	13,693	99	1,732,971	68,430
Michigan:								
Monroe	437,335	7,635	2,082	72	....	....	....	....
Grand total	3,546,752	59,198	8,788,625	333,844	13,693	99	4,915,357	188,033

State and county.	Pike perch (wall-eyed).		Pike perch (sauger).		Rock bass.		Sturgeon.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	12,786	$561	7,000	$490	....	....	103,030	$7,417
Chautauqua	8,580	349	....	....	500	$6	120,080	9,480
Total	21,366	910	7,000	490	500	6	223,110	16,897
Pennsylvania:								
Erie	13,633	953	7,427	321	....	....	60,820	4,027
Ohio:								
Ashtabula	....	....	....	....	....	....	90	6
Lake	11,685	760	....	....	....	....	4,864	302
Cuyahoga	72,756	3,737	95,775	2,972	....	....	699	47
Lorain	45,326	2,270	1,000	15	....	....	315	23
Erie	21,395	1,363	309,526	9,558	....	....	483	29
Sandusky	1,937	97	2,480	49	....	....	....	....
Ottawa	341,848	18,635	1,220,443	26,548	505	15	1,975	131
Lucas	142,038	7,441	228,404	5,806	....	....	....	....
Total	636,985	34,303	1,857,628	44,948	505	15	8,426	538
Michigan:								
Monroe	236,500	13,296	68,300	1,938	....	....	1,870	124
Grand total	908,484	49,462	1,940,355	47,697	1,005	21	294,226	21,586

Tables showing by states, counties, and species the yield of the fisheries of Lake Erie in 1903—Continued.

State and county.	Suckers.		Sun-fish.		Trout.		White bass.		White-fish.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:										
Erie	21,255	$191	1,200	$8	669	$39	....	....	5,477	$465
Chautauqua	39,333	1,054	....	....	12,370	675	500	$6	46,770	3,560
Total	60,588	1,245	1,200	8	13,039	714	500	6	52,247	4,025
Pennsylvania:										
Erie	58,355	865	....	....	....	....	800	24	53,276	3,885
Ohio:										
Lake	12,449	166	....	....	....	....	144	5	9,936	683
Cuyahoga	17,634	307	....	....	2,033	81	123	5	31,864	2,422
Lorain	16,323	225	....	....	....	....	785	29	10,053	774
Erie	66,742	768	....	....	55	5	3,258	114	28,572	2,228
Sandusky	11,010	112	....	....	....	....	2,970	89	5,019	373
Ottawa	258,464	2,541	....	....	....	....	16,384	590	86,901	6,710
Lucas	70,376	702	....	....	....	....	778	21	....	....
Total	452,998	4,821	....	....	2,088	86	24,442	853	172,355	13,190
Michigan:										
Monroe	149,148	1,764	....	....	....	....	1,900	57	24,927	1,888
Grand total	721,089	8,695	1,200	8	15,127	800	27,651	940	302,805	22,988

State and county.	Yellow perch.		Caviar.		Turtles.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	19,840	$707	2,906	$2,227	....	....	1,629,195	$71,636
Chautauqua	6,776	211	1,806	1,705	....	....	1,320,110	56,809
Total	26,616	918	4,712	3,932	....	....	2,949,305	128,445
Pennsylvania:								
Erie	141,139	5,258	840	670	....	....	8,367,707	305,244
Ohio:								
Ashtabula	....	....	....	....	....	....	1,090	56
Lake	382	9	275	247	....	....	261,445	7,893
Cuyahoga	300,051	11,003	....	....	....	....	2,764,035	116,089
Lorain	23,204	716	....	....	....	....	426,934	17,227
Erie	157,297	5,356	....	....	27,000	$1,620	1,267,570	39,929
Sandusky	12,260	193	....	....	....	....	146,917	2,624
Ottawa	108,692	2,078	....	....	18,800	752	4,893,701	106,619
Lucas	22,857	570	....	....	....	....	987,294	26,590
Total	624,743	19,925	275	247	45,800	2,372	10,748,986	317,027
Michigan:								
Monroe	37,905	900	50	45	....	....	1,122,558	29,299
Grand total	830,403	27,001	5,877	4,894	45,800	2,372	23,188,556	780,015

Table showing by states, counties, and species the yield of the vessel fisheries of Lake Erie in 1903.

State and county.	Fresh-water drum.		German carp.		Herring.		Ling or lawyer.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	....	....	....	....	849,972	$33,947	....	....
Chautauqua	....	....	....	....	411,628	16,376	....	....
Total	....	....	....	....	1,261,600	50,323	....	....
Pennsylvania:								
Erie	....	....	....	....	5,510,970	189,637	....	....
Ohio:								
Cuyahoga	380	$4	....	....	1,041,642	46,530	672	$14
Erie	355	2	....	....	174,548	7,709	....	....
Lucas	....	....	270	$2	210,230	8,408	....	....
Total	735	6	270	2	1,426,420	62,647	672	14
Grand total	735	6	270	2	8,198,990	302,607	672	14

Table showing by states, counties, and species the yield of the vessel fisheries of Lake Erie in 1903—Continued.

State and county	Pike perch (blue pike).		Pike perch (wall-eyed).		Pike perch (sauger).		Sturgeon.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	424,029	$14,807	286	$17			9,430	$537
Chautauqua	318,533	12,785	333	18			3,880	285
Total	742,562	27,592	619	35			13,310	822
Pennsylvania:								
Erie	1,762,482	65,364	1,985	120	7,427	$371		
Ohio:								
Cuyahoga	600,549	28,764	4,321	239	83,215	2,804		
Erie	24,407	1,094	1,933	100	199,981	7,112		
Lucas	16,459	576	947	57	147,722	3,793		
Total	641,415	30,434	7,201	396	430,918	13,709		
Grand total	3,146,459	123,390	9,805	551	438,345	14,080	13,310	822

State and county.	Suckers.		Trout.		White-fish.		Yellow perch.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:								
Erie	160	$1	669	$39	4,021	$321	4,260	$128
Chautauqua	1,988	16	12,175	663	37,026	2,962	2,838	88
Total	2,148	17	12,844	702	41,047	3,283	7,098	216
Pennsylvania:								
Erie	2,650	26			12,561	978	115,083	4,342
Ohio:								
Cuyahoga	3,155	45	2,033	81	19,569	1,565	257,720	9,726
Erie	3,299	41	55	5			114,625	4,079
Lucas	275	3					17,980	450
Total	6,729	89	2,088	86	19,569	1,565	390,325	14,255
Grand total	11,527	132	14,932	788	73,177	5,826	512,506	18,813

State and county.	Caviar.		Turtles.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
New York:						
Erie	296	$112			1,293,123	$49,909
Chautauqua	65	58			788,466	33,251
Total	361	170			2,081,589	83,160
Pennsylvania:						
Erie					7,413,158	260,838
Ohio:						
Cuyahoga					2,013,256	89,772
Erie			27,000	$1,620	546,203	21,762
Lucas					393,883	13,289
Total			27,000	1,620	2,953,342	124,823
Grand total	361	170	27,000	1,620	12,448,089	468,821

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Erie in 1903.

Apparatus and species.	Pennsylvania.		Michigan.		New York.	
	Erie County.		Monroe County.		Erie County.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:						
Cat-fish and bullheads	3,415	$210	7,616	$306		
Dog-fish or bowfin			1,062	6		
Fresh-water drum	43,561	593	133,557	682		
German carp	14,000	190	81,036	925		
Herring	20,127	890	2,082	72		
Pike perch (blue pike)	286,834	8,470				
Pike perch (wall-eyed)	6,948	506	222,839	12,894		
Pike perch (sauger)			59,775	1,612		
Sturgeon	39,960	2,637	1,870	124		
Caviar	800	640	50	45		
Suckers	22,605	291	113,871	1,272		
White bass	800	24	692	20		
White-fish	36,715	2,682	24,927	1,888		
Yellow perch	4,661	144	16,233	454		
Total	480,426	17,277	665,610	19,800		
Trap nets:						
Cat-fish and bullheads	8,400	487	5,592	214		
Fresh-water drum	16,500	245	6,189	33		
German carp	15,650	261	25,138	384		
Herring	4,500	120				
Pike perch (blue pike)	30,350	999				
Pike perch (wall-eyed)	4,700	327	8,471	593		
Pike perch (sauger)			6,946	278		
Sturgeon	5,560	370				
Caviar	40	30				
Suckers	33,100	548	25,135	376		
White bass			1,152	35		
Yellow perch	18,900	697	16,022	321		
Total	137,700	4,084	94,645	2,184		
Fyke nets:						
Cat-fish and bullheads			1,967	78		
German carp			48,958	494		
Pike perch (wall-eyed)			4,772	283		
Pike perch (sauger)			976	30		
Suckers			8,722	98		
Yellow perch			1,698	40		
Total			67,093	1,023		
Gill nets:						
Cat-fish and bullheads					2,271	$90
German carp					2,560	45
Herring	214,755	17,116			56,200	2,242
Pike perch (blue pike)	99,373	4,632				
Pike perch (wall-eyed)					8,500	264
Sturgeon					70,000	5,060
Caviar					1,810	1,470
Suckers					21,095	190
Sun-fish					1,200	8
White-fish	4,000	225			1,456	144
Yellow perch	2,495	75			9,580	159
Total	320,623	22,048			174,672	9,672
Seines:						
Cat-fish and bullheads			2,655	106		
German carp			282,203	5,882		
Pike perch (wall-eyed)			418	26		
Pike perch (sauger)			603	18		
Suckers			1,420	18		
White bass			65	2		
Yellow perch			3,952	85		
Total			291,316	6,137		
Lines:						
Cat-fish and bullheads	500	27	3,894	155		
Pike perch (blue pike)					120,000	8,400
Pike perch (wall-eyed)					4,000	280
Pike perch (sauger)					7,000	490
Sturgeon	15,300	1,020			23,600	1,820
Caviar					800	645
Yellow perch					6,000	420
Total	15,800	1,047	3,894	155	161,400	12,055
Grand total	954,549	44,456	1,122,558	29,299	336,072	21,727

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Erie in 1903—Continued.

Apparatus and species.	New York—Continued.				Ohio.			
	Chautauqua County.		Total.		Ashtabula.		Lake.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass	400	$36	400	$36				
Cat-fish and bullheads							7,662	$346
Fresh-water drum							23,612	187
German carp	18,000	360	18,000	360			18,350	233
Herring							3,744	129
Ling or lawyer							1,140	23
Pike perch (blue pike)	1,000	35	1,000	35			167,202	4,803
Pike perch (wall-eyed)	600	42	600	42			11,685	760
Sturgeon	66,600	5,324	66,600	5,324			4,864	302
Caviar	1,200	1,140	1,200	1,140			275	247
Suckers	33,400	994	33,400	994			12,449	166
White bass							144	5
White-fish							9,936	683
Yellow perch	200	7	200	7			382	9
Total	121,400	7,938	121,400	7,938			261,445	7,893
Trap nets:								
Black bass	3,000	225	3,000	225				
Cat-fish and bullheads	300	18	300	18				
Fresh-water drum	800	12	800	12				
German carp	1,000	12	1,000	12				
Pike perch (blue pike)	4,000	140	4,000	140				
Pike perch (wall-eyed)	7,500	280	7,500	280				
Rock bass	500	6	500	6				
Sturgeon	6,600	464	6,600	464				
Sturgeon caviar	150	142	150	142				
Suckers	3,550	41	3,550	41				
White bass	500	6	500	6				
Yellow perch	1,000	22	1,000	22				
Total	28,900	1,368	28,900	1,368				
Gill nets:								
Black bass	732	65	732	65				
Cat-fish and bullheads			2,271	90				
German carp			2,560	45				
Herring	187,524	5,667	243,724	7,909				
Pike perch (blue pike)	134,674	3,932	134,674	3,932				
Pike perch (wall-eyed)	138	8	8,638	272				
Sturgeon	13,900	1,099	83,900	6,159				
Caviar	16	9	1,826	1,479				
Suckers	395	3	21,490	193				
Sun-fish			1,200	8				
Trout	195	12	195	12				
White-fish	9,744	598	11,200	742				
Yellow perch	2,557	88	12,137	247				
Total	349,875	11,481	524,547	21,153				
Lines:								
Black bass	693	61	693	61				
Cat-fish and bullheads					1,000	$50		
Pike perch (blue pike)	1,111	39	121,111	8,439				
Pike perch (wall-eyed)	9	1	4,009	281				
Pike perch (sauger)			7,000	490				
Sturgeon	29,100	2,308	52,700	4,128	90	6		
Caviar	375	356	1,175	1,001				
Yellow perch	181	6	6,181	426				
Total	31,469	2,771	192,869	14,826	1,090	56		
Grand total	531,644	23,558	867,716	45,285	1,090	56	261,415	7,893

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Erie in 1903—Continued.

Apparatus and species.	Ohio—Continued.							
	Cuyahoga.		Lorain.		Erie.		Sandusky.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Cat-fish and bullheads	900	$38	500	$20	2,182	$98		
Fresh-water drum	7,534	73	4,000	20	30,940	267		
German carp	11,712	273	15,616	300	13,200	222		
Herring	52,429	2,599	28,256	1,412	12,714	622		
Ling or lawyer	11,538	61						
Pike perch (blue pike)	515,744	17,159	240,046	10,983	139,631	4,087		
Pike perch (wall-eyed)	68,435	3,498	45,026	2,246	7,823	515		
Pike perch (sauger)	12,560	168	1,000	15	43,242	1,036		
Sturgeon	699	47	315	23	450	27		
Suckers	14,479	262	6,323	125	17,524	231		
White bass	123	5	285	14	50	2		
White-fish	12,295	857	10,063	774	12,991	1,043		
Yellow perch	42,331	1,277	23,204	716	16,152	750		
Total	750,779	26,317	374,634	16,648	296,899	8,900		
Trap nets:								
Cat-fish and bullheads					4,007	182		
Fresh-water drum					6,890	41		
German carp					11,600	174		
Pike perch (blue pike)					12,733	387		
Pike perch (wall-eyed)					6,818	461		
Pike perch (sauger)					14,492	290		
Suckers					18,744	255		
White bass					685	27		
Yellow perch					7,632	172		
Total					83,601	1,989		
Fyke nets:								
Cat-fish and bullheads			1,000	40	2,284	91	2,583	$104
Fresh-water drum			20,000	100	4,567	46		
German carp			4,000	40	29,096	380	57,950	834
Pike perch (blue pike)			4,000	120	359	14		
Pike perch (wall-eyed)			300	24	4,168	243	1,937	97
Pike perch (sauger)					43,081	944	1,600	32
Suckers			10,000	100	25,888	231	11,010	112
White bass			500	15	2,523	85	2,970	89
Yellow perch					9,383	196	12,260	193
Total			39,800	439	121,349	2,230	90,310	1,461
Gill nets:								
Cat-fish and bullheads					18	1		
German carp					1,237	24	708	23
Herring					497	23		
Pike perch (wall-eyed)					520	36		
Pike perch (sauger)					8,230	166	880	17
Suckers					227	2		
White-fish					15,581	1,185	5,019	373
Yellow perch					9,505	159		
Total					35,815	1,596	6,607	413
Seines:								
Cat-fish and bullheads					2,876	115		
German carp					178,077	3,268	50,000	750
Pike perch (wall-eyed)					133	8		
Pike perch (sauger)					500	10		
Suckers					1,060	8		
Total					182,646	3,409	50,000	750
Lines:								
Cat-fish and bullheads			500	20	1,024	41		
Sturgeon					33	2		
Total			500	20	1,057	43		
Minor apparatus:								
Carp			12,000	120				
Grand total	750,779	26,317	426,934	17,227	721,367	18,167	146,917	2,624

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Erie in 1903—Continued.

Apparatus and species.	Ohio—Continued.						Grand total.	
	Ottawa.		Lucas.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Pound nets:								
Black bass							400	$36
Cat-fish and bullheads	39,460	$1,521	10,021	$401	60,725	$2,424	71,756	2,940
Dog-fish or bowfin							1,062	6
Fresh-water drum	160,515	985	49,690	248	276,291	1,780	453,409	3,055
German carp	25,635	421	29,773	297	114,286	1,746	227,322	3,221
Herring	603	30			97,746	4,792	119,955	5,754
Ling, or lawyer					12,678	84	12,678	84
Pike perch (blue pike)	4,112	186			1,066,735	37,218	1,354,569	45,723
Pike perch (wall-eyed)	187,569	9,558	122,221	6,252	442,759	22,829	673,146	35,771
Pike perch (sauger)	567,299	11,654	75,923	1,896	700,024	14,769	759,799	16,381
Sturgeon	1,975	131			8,303	530	116,733	8,615
Caviar					275	247	2,325	2,072
Suckers	133,756	1,334	58,649	586	243,180	2,704	413,056	5,261
White bass	2,088	62	415	11	3,105	99	4,597	143
White-fish	19,626	1,413			64,911	4,770	126,553	9,340
Yellow perch	26,997	407	4,304	106	113,370	3,265	134,464	3,870
Total	1,169,635	27,702	350,996	9,797	3,204,388	97,257	4,471,824	142,272
Trap nets:								
Black bass							3,000	225
Cat-fish and bullheads	39,793	1,576	992	40	44,792	1,798	59,084	2,517
Fresh-water drum	82,305	538	9,190	91	98,385	670	121,874	960
German carp	258,513	4,256	2,358	24	272,471	4,454	314,259	5,061
Herring	3,117	161			3,117	161	7,617	281
Pike perch (blue pike)	6,601	233			19,334	620	53,684	1,759
Pike perch (wall-eyed)	70,230	3,617	10,452	627	87,500	4,705	108,171	5,905
Pike perch (sauger)	377,793	7,947	1,480	36	393,765	8,273	400,711	8,551
Rock bass	245	7			245	7	745	13
Sturgeon							12,160	834
Caviar							190	172
Suckers	75,239	748	5,981	59	99,964	1,062	161,749	2,027
White bass	12,106	460	40	1	12,831	488	14,483	529
White-fish	12,713	971			12,713	971	12,713	971
Yellow perch	51,532	985	70	2	59,234	1,159	95,156	2,199
Total	990,187	21,499	30,563	880	1,104,351	24,368	1,365,596	32,004
Fyke nets:								
Cat-fish and bullheads	25,861	996	703	28	32,431	1,259	34,398	1,337
Fresh-water drum	37,210	313			61,777	459	61,777	459
German carp	221,627	3,614	16,436	164	329,109	5,032	378,067	5,526
Herring	3,000	150			3,000	150	3,000	150
Ling or lawyer	343	1			343	1	343	1
Pike perch (blue pike)	1,128	24			5,487	158	5,487	158
Pike perch (wall-eyed)	24,009	1,258	7,281	436	37,695	2,058	42,467	2,341
Pike perch (sauger)	213,703	4,436	2,405	60	260,789	5,472	261,765	5,502
Rock bass	260	8			260	8	260	8
Suckers	49,310	457	2,811	28	99,019	928	107,741	1,026
White bass	2,190	68	180	5	8,363	262	8,363	262
White-fish	6,787	514			6,787	514	6,787	514
Yellow perch	25,860	518	331	8	47,834	915	49,532	955
Total	611,288	12,357	30,147	729	892,894	17,216	959,987	18,239
Gill nets:								
Black bass							732	65
Cat-fish and bullheads					18	1	2,289	91
German carp	929	27			2,874	74	5,434	119
Herring	87	4			584	27	459,063	25,052
Pike perch (blue pike)							234,047	8,564
Pike perch (wall-eyed)	40	3			560	39	9,198	311
Pike perch (sauger)	848	31			9,958	214	9,958	214
Sturgeon							83,900	6,159
Caviar							1,826	1,479
Suckers	159	2			386	4	21,876	197
Sun-fish							1,200	8
Trout							195	12
White-fish	47,775	3,812			68,375	5,370	83,575	6,337
Yellow perch	303	8			9,808	167	24,440	489
Total	50,141	3,887			92,563	5,896	937,733	49,097
Seines:								
Cat-fish and bullheads			549	22	3,425	137	6,080	243
Fresh-water drum			4,650	33	4,650	33	4,650	33
German carp	1,927,600	33,533	171,520	1,716	2,327,197	39,267	2,609,400	45,149

Table showing by states, counties, apparatus, and species the yield of the shore fisheries of Lake Erie in 1903—Continued.

Apparatus and species.	Ohio—Continued.						Grand total.	
	Ottawa.		Lucas.		Total.			
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Seines—Continued.								
Pike perch (wall-eyed)			1,137	$69	1,270	$77	1,688	$103
Pike perch (sauger)			874	21	1,374	31	1,977	49
Suckers			2,660	26	3,720	34	5,140	52
White bass			143	4	143	4	208	6
Yellow perch			172	4	172	4	4,124	89
Total	1,927,600	$33,533	181,705	1,895	2,341,951	39,587	2,633,267	45,724
Lines:								
Black bass							693	61
Cat-fish and bullheads	1,250	50			3,774	161	8,168	343
Pike perch (blue pike)							121,111	8,439
Pike perch (wall-eyed)	60,000	4,199			60,000	4,199	64,009	4,480
Pike perch (sauger)	60,800	2,430			60,800	2,430	67,800	2,920
Sturgeon					123	8	68,123	5,156
Caviar							1,175	1,001
Yellow perch	4,000	160			4,000	160	10,181	586
Total	126,050	6,839			128,697	6,958	341,260	22,986
Turtle nets:								
Turtles	18,800	752			18,800	752	18,800	752
Minor apparatus:								
Carp					12,000	120	12,000	120
Grand total	4,893,701	106,569	593,411	13,301	7,795,644	192,154	10,740,467	311,194

WHOLESALE FISHERY TRADE.

In the wholesale fishery trade of Lake Erie in 1903 there were 32 establishments, representing an investment, including cash or working capital, of $1,269,870. The number of persons engaged was 498, and the amount of wages paid was $268,538. The products aggregated 39,923,261 pounds, valued at $2,173,891. They were derived chiefly from the American fisheries of Lake Erie, but also included a part of the catch from the Canadian side of the lake, and a few salt-water species, both domestic and imported.

Table showing the wholesale fishery trade of Lake Erie in 1903.

Items.	Toledo, Ohio.		Port Clinton, Ohio.		Sandusky, Ohio.		Cleveland and Lorain, Ohio.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	2	$62,500	2	$45,775	4	$119,000	5	$345,100
Cash capital		15,000		20,000		57,000		98,500
Wages paid		5,850		15,000		30,960		117,000
Employees	12		24		46		145	
Products handled.	**Lbs.**	**Value.**	**Lbs.**	**Value.**	**Lbs.**	**Value.**	**Lbs.**	**Value.**
Fresh:								
Blue-fish	38,017	3,261			20,000	2,000	4,031	402
Cat-fish and bullheads	37,766	1,887	80,647	4,032	261,568	11,345	43,549	3,138
Cod							6,928	315
Eels	25	2			185	19	2,904	208
Fresh-water drum	49,969	691	234,140	2,341	260,366	2,982	41,288	803
German carp	393,366	7,048	3,452,457	61,072	1,168,912	28,538	50,880	1,328
Haddock							7,427	199

Table showing the wholesale fishery trade of Lake Erie in 1903—Continued.

Products handled.	Toledo, Ohio.		Port Clinton, Ohio.		Sandusky, Ohio.		Cleveland and Lorain, Ohio.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fresh—Continued.								
Halibut							4,674	$420
Lake herring	114,438	$7,394	63,686	$4,392	960,176	$58,708	928,062	43,093
Lake trout	43,102	3,448			60,000	5,000	91,218	7,057
Ling or lawyer			25,306	375	30	1	8,355	73
Mooneye					233	2		
Muskellunge	68	5						
Pike and pickerel	739,465	59,157	247,707	78,816	138,836	9,130	142,119	7,818
Pike perch (blue pike)	34,525	1,951	6,857	411	721,344	20,457	865,072	39,787
Pike perch (sauger)	323,288	11,950	845,227	28,236	745,635	29,494	80,829	3,206
Pike perch (wall-eyed)					150,000	12,000	23,268	1,321
Red snapper							3,437	274
Rock bass			625	37				
Salmon							11,339	1,133
Shad							212	25
Smelt					10,000	900	12,454	124
Spanish mackerel	4,000	320			100,000	10,000	871	78
Sturgeon	483	60	1,312	144	43,880	4,212	6,193	678
Suckers	160,241	2,955	185,662	3,412	306,236	4,805	28,039	674
Sun-fish			10,996	275			200	6
White bass	964	51	7,666	426	10,912	473	1,247	62
White-fish	201,336	23,207	33,761	3,318	364,288	29,763	310,092	24,394
White-fish (blue fin)					10,000	700		
White-fish (Tullibee)	12,122	545			20,000	1,400	4,424	198
Yellow perch	55,349	2,629	84,339	3,372	309,336	10,011	232,631	9,517
Caviar					3,826	2,749		
Turtles	417	25	44,185	2,651				
Frogs			109	355				
Shad roe					1,125	375	23	9
Total	2,208,941	126,526	5,324,682	193,665	5,666,888	245,064	2,911,761	146,340
Salted:								
Herring, domestic							418,550	10,463
Trout							2,839	128
White-fish							32,037	1,921
Total							453,426	12,512
Smoked:								
Finnan haddie					5,000	400		
Herring					75,000	7,500		
Sturgeon					10,000	2,400		
White-fish					10,000	1,200		
Total					100,000	11,500		
Grand total	2,208,941	126,526	5,324,682	193,665	5,766,888	256,564	3,365,187	158,852

Item.	Erie, Pa.		Dunkirk and Westfield, N. Y.		Buffalo and Angola, N. Y.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Establishments	5	$127,950	5	$16,600	9	$146,195	32	$863,120
Cash capital		64,000		22,000		135,250		406,750
Wages paid		37,551		8,394		53,783		268,538
Employees	135		25		111		498	
Products handled.	**Lbs.**	**Value.**	**Lbs.**	**Value.**	**Lbs.**	**Value.**	**Lbs.**	**Value.**
Fresh:								
Black bass			4,450	$436	71,787	$9,207	76,237	$9,643
Blue-fish					50,133	4,533	112,181	10,136
Bonito					52	4	52	4
Brook trout					3,240	1,051	3,240	1,051
Butter-fish					80	6	80	6
Cat-fish and bullheads	5,586	$279	418	29	308,143	34,251	737,677	54,961
Cod					61,178	2,337	68,101	2,652
Eels					43,799	3,613	46,913	3,842
Flounders					9,292	395	9,292	395
Fresh-water drum	38,867	418	800	10	8,385	595	633,815	7,840
German carp	26,253	375	2,454	39	235,687	6,827	5,330,009	105,227
Haddock					21,161	869	28,588	1,068
Halibut					91,523	8,269	96,197	8,689

Table showing the wholesale fishery trade of Lake Erie in 1903—Continued.

Products.	Erie, Pa.		Dunkirk and Westfield, N. Y.		Buffalo and Angola, N. Y.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fresh—Continued.								
Lake herring	3,883,748	$211,366	1,519,993	$77,126	1,586,467	$103,627	9,056,570	$505,706
Lake trout	8,514	716	16,258	957	1,258,118	125,374	1,477,210	142,552
Ling or lawyer							33,691	449
Mackerel					14,377	3,016	14,377	3,016
Mooneye					14,702	436	14,935	438
Muskellunge					1,331	154	1,399	159
Pike and pickerel	24,203	2,089	6,973	448	516,826	31,011	1,816,129	188,469
Pike perch (blue pike)	1,661,231	84,423	1,056,695	48,525	1,351,124	83,922	5,696,848	279,476
Pike perch (sauger)	2,035	61			1,952	117	1,998,966	73,064
Pike perch (wall-eyed)					914,777	84,168	1,088,045	97,489
Pollock					4,000	160	4,000	160
Red snapper					2,844	258	6,281	532
Rock bass			500	10	5,293	159	6,418	206
Salmon					25,296	2,799	36,635	3,932
Scup					50	4	50	4
Sea bass					6,063	485	6,063	485
Shad					1,301	104	1,518	129
Sheepshead					110,595	3,317	110,595	3,317
Smelt	272	27			126,602	10,562	149,328	11,613
Spanish mackerel					1,316	216	106,187	10,614
Squeteague					28,335	1,719	28,335	1,719
Sturgeon	5,440	587	12,768	1,608	630,173	86,648	700,249	93,937
Suckers	37,854	657	11,115	160	105,714	3,170	834,891	15,833
Sun-fish					6,942	208	18,138	489
White bass	355	17	500	10	304	9	21,948	1,048
White-fish	103,339	10,073	115,390	7,986	1,538,410	129,859	2,666,616	228,600
White-fish (bluefin)					6,400	293	16,400	993
White-fish (Tullibee)					94,630	5,212	131,176	7,355
Yellow perch	29,519	1,475	56,991	2,839	291,779	14,590	1,059,944	44,433
Caviar	2,940	2,793	110	103	24,092	20,604	30,968	26,249
Turtles							44,602	2,676
Frogs					2,825	1,130	2,934	1,485
Shad roe					4,083	1,052	5,231	1,436
Sturgeon bladders					166	100	166	100
Total	5,830,156	315,356	2,805,445	140,286	9,581,347	786,440	34,329,220	1,953,677
Salted:								
German carp					679	20	679	20
Herring, domestic							418,550	10,463
Herring, Holland					5,605	474	5,605	474
Herring, Scotch					3,000	225	3,000	225
Lake herring					4,010,297	97,359	4,010,297	97,359
Mackerel					19,948	1,863	19,948	1,863
Pickerel					19,833	793	19,833	793
Pike perch (blue pike)					8,148	292	8,148	292
Russian sardines					3,000	1,350	3,000	1,350
Scup					45	3	45	3
Trout					200,106	15,186	202,945	15,314
White-fish					34,719	1,736	66,756	3,657
Total					4,305,380	119,301	4,758,806	131,813
Smoked:								
Eels					23,356	2,707	23,356	2,707
Finnan, haddie					28,933	763	33,933	1,163
Herring					124,600	11,721	199,600	19,221
Herring, bloater					17,685	692	17,685	692
Lake herring	15,000	1,200			43,492	4,797	58,492	5,997
Sturgeon	10,000	1,500			1,221	267	21,221	4,167
White-fish							10,000	1,200
Total	25,000	2,700			239,287	20,947	364,287	35,147
Other products:								
Clams					a 11,248	4,500	11,248	4,500
Oysters					b 459,700	48,754	459,700	48,754
Total					470,948	53,254	470,948	53,254
Grand total	5,855,156	318,056	2,805,445	140,286	14,596,962	979,942	39,923,261	2,173,891

a 562,500 in number.
b 45,970 gallons. Weight of oysters and edible part of clams estimated.

FISHERIES OF LAKE ONTARIO.

The number of persons employed in the fisheries of Lake Ontario in 1903 was 305, of whom 10 were on vessels fishing and transporting, 276 in the shore or boat fisheries, and 19 were shoresmen.

The investment, which amounted to $94,379, included 3 vessels of 34 net tons, valued at $4,400, with outfits valued at $560; 171 boats valued at $6,869, 5 gasoline launches valued at $3,000, fishing apparatus used on vessels and boats valued at $31,855, shore and accessory property valued at $21,945, and cash capital amounting to $25,750.

The products of the fisheries of this lake aggregated 1,075,448 pounds, with a value to the fishermen of $47,739. The catch taken by vessels was 14,150 pounds, valued at $588, and by boats 1,061,298 pounds, valued at $47,151. The vessel catch was obtained by 2 vessels with 620 gill nets, valued at $2,920. In the shore or boat fisheries gill nets took 253,308 pounds, $13,708; pound nets and trap nets, 322,976 pounds, $13,084; fyke nets, 380,112 pounds, $14,398; seines, 32,760 pounds, $905; hand lines, 32,200 pounds, $1,974; set lines, 39,442 pounds, $2,832; and spears, 500 pounds, $250. The spear catch consisted wholly of frogs. The principal fishes taken were cat-fish and bullheads, 349,224 pounds, $12,903; sturgeon, including caviar, 112,443 pounds, $8,057; herring, fresh and salted, 121,315 pounds, $5,810; eels, 73,595 pounds, $4,233; pike and pickerel, 31,359 pounds, $2,080; blue pike, 60,565 pounds, $2,913; yellow perch, 122,165 pounds, $3,971; and white-fish, 25,384 pounds, $2,122. Several other species were obtained in smaller quantities.

Compared with 1899 there has been a slight decrease in the number of persons employed, with an increase of $15,836, or 20 per cent, in the investment, but the products have decreased 1,235,814 pounds, or over 53 per cent, in quantity, and $45,654, or nearly 49 per cent, in value.

The following tables show by counties the extent of the fisheries of Lake Ontario in 1903:

Table showing by counties the persons employed in the fisheries of Lake Ontario in 1903.

County.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
Jefferson			142	18	160
Oswego			25	1	26
Cayuga			6		6
Wayne		2	23		25
Monroe	4		20		24
Orleans			17		17
Niagara	4		43		47
Total	8	2	276	19	305

Table showing by counties the vessels, boats, apparatus, and capital employed in the fisheries of Lake Ontario in 1903.

Item.	Jefferson.		Oswego.		Cayuga.		Wayne.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels, transporting							1	$400
Tonnage							14	
Outfit								50
Boats	99	$2,579	16	$950	3	$70	11	485
Launches	2	1,300						
Apparatus—shore fisheries:								
Seines	4	120						
Gill nets	313	3,028	136	2,299	2	10	73	765
Trap nets	152	5,915			5	250	11	550
Fyke nets	509	7,161						
Hand lines		22						3
Set lines ....yards	10,000	150	28,333	210			800	8
Spears	6	6						
Shore and accessory property		15,935		1,225		120		515
Cash capital		25,000		750				
Total		61,246		5,434		450		2,776

Item.	Monroe.		Orleans.		Niagara.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels, fishing	1	$2,000			1	$2,000	2	$4,000
Tonnage	8				12		20	
Outfit		410				100		510
Vessels, transporting							1	400
Tonnage							14	
Outfit								50
Boats	13	730	9	$540	20	1,515	171	6,869
Launches					3	1,700	5	3,000
Apparatus—vessel fisheries: Gill nets	500	2,500			120	420	620	2,920
Apparatus—shore fisheries:								
Seines							4	120
Gill nets	93	1,425	30	350	529	3,065	1,176	10,942
Pound nets					8	3,200	8	3,200
Trap nets							168	6,745
Fyke nets							509	7,161
Hand lines								25
Set lines ....yards	8,000	37	16,160	103	37,240	228	100,533	736
Spears							6	6
Shore and accessory property		2,085		415		1,650		21,945
Cash capital								25,750
Total		9,187		1,408		13,878		94,879

Table showing by counties and species the yield of the fisheries of Lake Ontario in 1903.

Species.	Jefferson.		Oswego.		Cayuga.		Wayne.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	28,175	$1,792					160	$21
Cat-fish and bullheads	347,524	12,842			1,500	$53	200	8
Eels	68,545	3,915			550	26	3,300	228
German carp	4,020	176						
Herring, fresh	10,300	503	1,350	$83	225	11	5,915	386
Herring, salted	16,000	640						
Ling or lawyer	600	18						
Pike and pickerel	28,759	1,872			500	40	2,100	168
Pike perch (blue pike)	9,839	530	6,372	381	550	33	5,057	387
Pike perch (wall-eyed)	7,825	626					160	21
Rock bass	19,910	219			529	11	1,290	52
Sturgeon	33,300	1,561	18,610	1,010			1,740	143
Caviar	20	16	705	529				
Suckers	54,775	1,142	2,300	71	5,500	110	1,545	46
Sun-fish	23,449	360			10,000	100	640	22
Trout	3,700	246						
White-fish	4,460	334	560	56				
Yellow perch	102,490	2,971	900	43	2,075	81	8,665	496
Frogs	500	250						
Total	764,191	30,013	30,797	2,173	21,429	465	30,772	1,978

Species.	Monroe.		Orleans.		Niagara.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass							28,335	$1,813
Cat-fish and bullheads							349,224	12,903
Eels					1,200	$64	73,595	4,233
Fresh-water drum					4,300	86	4,300	86
German carp					300	16	4,320	192
Herring, fresh	28,999	$1,296	10,526	$577	48,000	2,314	105,315	5,170
Herring, salted							16,000	640
Ling or lawyer							600	18
Pike and pickerel							31,359	2,080
Pike perch (blue pike)	2,349	136	4,498	212	31,900	1,234	60,565	2,913
Pike perch (wall-eyed)					40	3	8,025	650
Rock bass					390	39	22,119	321
Sturgeon	7,320	416	7,176	451	42,050	2,708	110,196	6,289
Caviar	75	60	84	67	1,363	1,096	2,247	1,768
Suckers	5,450	113	840	44	2,650	33	73,060	1,559
Sun-fish							34,089	482
Trout			40	4	310	29	4,050	279
White-fish	985	95	2,750	275	16,629	1,362	25,384	2,122
Yellow perch	2,055	154	1,230	60	4,750	166	122,165	3,971
Frogs							500	250
Total	47,233	2,270	27,144	1,690	153,882	9,150	1,075,448	47,739

Table showing by counties, apparatus, and species the yield of the vessel fisheries of Lake Ontario in 1903.

Apparatus and species.	Monroe.		Niagara.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:						
Herring	12,000	$480	1,700	$85	13,700	$565
Pike perch (blue pike)	250	15			250	15
Suckers	200	8			200	8
Total	12,450	503	1,700	85	14,150	588

Table showing by counties, apparatus, and species the yield of the shore fisheries of Lake Ontario in 1903.

Apparatus and species.	Jefferson.		Oswego.		Cayuga.		Wayne.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Cat-fish and bullheads	15,392	$596						
Eels	100	8						
Herring, fresh	1,200	48	1,350	$83	225	$11	5,900	$384
Herring, salted	16,000	640						
Ling or lawyer	600	18						
Pike and pickerel	6,600	396			500	40	100	8
Pike perch (blue pike)	2,614	167	6,372	381			4,900	376
Sturgeon	17,500	651	13,160	737			400	20
Caviar	20	16	380	285				
Suckers	1,258	45	2,300	71			240	9
Sun-fish	300	9						
Trout	2,500	150						
White-fish	1,870	127	560	56				
Yellow perch	775	37	900	43	1,800	72	2,400	178
Total	66,729	2,908	25,022	1,656	2,525	123	13,940	975
Pound nets and trap nets:								
Black bass	3,975	278					160	21
Cat-fish and bullheads	105,700	3,529			1,500	53	200	8
Eels	38,525	2,427			550	26	700	46
German carp	1,800	70						
Herring	9,100	455					15	2
Pike and pickerel	8,700	522						
Pike perch (blue pike)	7,025	351			550	33	157	11
Pike perch (wall-eyed)	7,475	598					160	21
Rock bass	12,000	120			529	11	1,290	52
Sturgeon	800	40					1,340	123
Suckers	21,200	361			5,500	110	1,305	37
Sun-fish	11,000	110			10,000	100	640	22
White-fish	1,690	135						
Yellow perch	20,700	532			275	9	265	18
Total	249,690	9,528			18,904	342	6,232	361
Fyke nets:								
Cat-fish and bullheads	215,232	8,339						
Eels	28,330	1,388						
German carp	1,500	73						
Pike and pickerel	11,159	802						
Rock bass	5,510	73						
Sturgeon	4,800	360						
Suckers	21,617	629						
Sun-fish	11,649	236						
Trout	1,200	96						
White-fish	900	72						
Yellow perch	78,215	2,330						
Total	380,112	14,398						
Seines:								
Cat-fish and bullheads	11,200	378						
Eels	1,590	92						
German carp	720	33						
Pike and pickerel	2,300	152						
Pike perch (blue pike)	200	12						
Pike perch (wall-eyed)	350	28						
Rock bass	2,400	26						
Suckers	10,700	107						
Sun-fish	500	5						
Yellow perch	2,800	72						
Total	32,760	905						
Hand lines:								
Black bass	24,200	1,514						
Pike and pickerel							2,000	160
Yellow perch							6,000	300
Total	24,200	1,514					8,000	460
Set lines:								
Eels							2,600	182
Sturgeon	10,200	510	5,450	273				
Caviar			325	244				
Total	10,200	510	5,775	517			2,600	182
Spears:								
Frogs, dressed	500	250						
Grand total	764,191	30,013	30,797	2,173	21,429	465	30,772	1,978

Table showing by counties, apparatus, and species the yield of the shore fisheries of Lake Ontario in 1903—Continued.

Apparatus and species.	Monroe.		Orleans.		Niagara.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Gill nets:								
Cat-fish and bullheads							15,392	$596
Eels					1,200	$64	1,300	72
Herring, fresh	16,999	$816	10,526	$577	43,100	2,149	79,300	4,068
Herring, salted							16,000	640
Ling or lawyer							600	18
Pike and pickerel							7,200	444
Pike perch (blue pike)	2,099	121	4,498	212	18,400	829	38,883	2,086
Pike perch (wall-eyed)					40	3	40	3
Rock bass					390	39	390	39
Sturgeon	5,020	278	592	44	11,300	879	47,972	2,609
Caviar	20	16			119	98	539	415
Suckers	5,250	105	840	44	950	10	10,838	284
Sun-fish							300	9
Trout			40	4	310	29	2,850	183
White-fish	985	95	2,750	275	11,929	986	18,094	1,539
Yellow perch	2,055	154	1,230	60	4,450	159	13,610	703
Total	32,428	1,585	20,476	1,216	92,188	5,245	253,308	13,708
Pound nets and trap nets:								
Black bass							4,135	299
Cat-fish and bullheads							107,400	3,590
Eels							39,775	2,499
Fresh-water drum					4,300	86	4,300	86
German carp					300	16	2,100	86
Herring					3,200	80	12,315	537
Pike and pickerel							8,700	522
Pike perch (blue pike)					13,500	405	21,232	800
Pike perch (wall-eyed)							7,635	619
Rock bass							13,819	183
Sturgeon					19,200	1,100	21,340	1,263
Caviar					950	760	950	760
Suckers					1,700	23	29,705	531
Sun-fish							21,640	232
White-fish					4,700	376	6,390	511
Yellow perch					300	7	21,540	566
Total					48,150	2,853	322,976	13,084
Fyke nets:								
Cat-fish and bullheads							215,232	8,339
Eels							28,330	1,388
German carp							1,500	73
Pike and pickerel							11,159	802
Rock bass							5,510	73
Sturgeon							4,800	360
Suckers							21,617	629
Sun-fish							11,649	236
Trout							1,200	96
White-fish							900	72
Yellow perch							78,215	2,330
Total							380,112	14,398
Seines:								
Cat-fish and bullheads							11,200	378
Eels							1,590	92
German carp							720	33
Pike and pickerel							2,300	152
Pike perch (blue pike)							200	12
Pike perch (wall-eyed)							350	28
Rock bass							2,400	26
Suckers							10,700	107
Sun-fish							500	5
Yellow perch							2,800	72
Total							32,760	905
Hand lines:								
Black bass							24,200	1,514
Pike and pickerel							2,000	160
Yellow perch							6,000	300
Total							32,200	1,974
Set lines:								
Eels							2,600	182
Sturgeon	2,300	138	6,584	407	11,550	729	36,084	2,057
Caviar	55	44	84	67	294	238	758	598
Total	2,355	182	6,668	474	11,844	967	39,442	2,832
Spears:								
Frogs, dressed							500	250
Grand total	34,783	1,767	27,144	1,690	152,182	9,065	1,061,298	47,151

FISHERIES OF THE ST. LAWRENCE RIVER.

The fisheries of the St. Lawrence River in 1903, as here considered, were confined to St. Lawrence County, N. Y. The number of persons employed was 57; the capital invested amounted to $5,803; and the catch consisted of 18,000 pounds of suckers, valued at $90; and 112,002 pounds of sturgeon and sturgeon eggs, valued at $10,149; a total of 130,002 pounds, valued at $10,239. The suckers were caught with seines and the sturgeon with set lines. The sturgeon eggs are sold fresh to dealers for use in making caviar.

Table showing the persons, apparatus, etc., employed in the fisheries of the St. Lawrence River in 1903.

Item.	St. Lawrence County.	
	No.	Value.
Fishermen	57	....
Shoresmen	9	....
Boats	54	$603
Seines	3	60
Set lines	......	765
Shore property	......	1,125
Cash capital	......	3,250
Total	......	5,803

Table showing, by apparatus and species, the yield of the fisheries of the St. Lawrence River in 1903.

Apparatus and species.	St. Lawrence County.	
	Lbs.	Value.
Seines:		
Suckers	18,000	$90
Set lines:		
Sturgeon	101,894	5,095
Sturgeon eggs	10,108	5,054
Total	112,002	10,149
Grand total	130,002	10,239

FISHERIES OF THE NIAGARA RIVER.

The fisheries of the Niagara River are prosecuted in Niagara and Erie counties, N. Y. In 1903 the number of persons employed was 17 the investment was $810, and the products amounted to 39,150 pounds, valued at $1,375. The catch consisted of blue pike, 5,500 pounds, $440; white bass, 2,000 pounds, $40; yellow perch, 10,000 pounds, 300; German carp, 12,000 pounds, $240; suckers, 8,000 pounds, $160; and sturgeon, including sturgeon eggs, 1,650 pounds, $195. The German carp and suckers were taken with seines, the greater part of the sturgeon with spears, and the remainder of the catch, including 500 pounds of sturgeon, valued at $60, with "fishing machines."

Table showing by counties the persons, apparatus, etc., employed in the fisheries of the Niagara River in 1903.

Item.	Niagara.		Erie.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Fishermen	14		3		17	
Boats			1	$25	1	$25
Seines			1	25	1	25
Fishing machines	6	$600			6	600
Spears	8	10			8	10
Shore property		150				150
Total		760		50		810

Table showing by counties, apparatus, and species the yield of the fisheries of the Niagara River in 1903.

Apparatus and species.	Niagara.		Erie.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Fishing machines:						
Pike perch (blue pike)	5,500	$440			5,500	$440
Sturgeon	500	60			500	60
White bass	2,000	40			2,000	40
Yellow perch	10,000	300			10,000	300
Total	18,000	840			18,000	840
Seines:						
German carp			12,000	$240	12,000	240
Suckers			8,000	160	8,000	160
Total			20,000	400	20,000	400
Spears:						
Sturgeon	1,000	60			1,000	60
Sturgeon eggs	150	75			150	75
Total	1,150	135			1,150	135
Grand total	19,150	975	20,000	400	39,150	1,375

THE FISHERIES CONSIDERED BY STATES.

The fisheries of the Great Lakes are prosecuted in the following states: New York, Pennsylvania, Ohio, Indiana, Illinois, Michigan, Wisconsin, and Minnesota. Michigan borders on five lakes, and New York and Wisconsin each on two lakes.

The states in which the fisheries were most important in 1903 with regard to the number of persons employed were Michigan, 3,790; Wisconsin, 1,636; New York, 1,405, and Ohio, 1,101. The number was considerably smaller in each of the other states. The states having the largest investment were Illinois, $2,208,025; Michigan, $2,037,580; Ohio, $1,205,002, and Wisconsin, $846,369. New York had an investment of $571,598; Pennsylvania, $495,959; Minnesota, $96,406, and Indiana, $13,483. The large investment in Illinois is due chiefly to the extensive wholesale fishery trade centering at Chicago. The states in which the yield was greatest were Michigan, 35,608,557 pounds, valued at $1,223,792; Wisconsin, 24,191,599 pounds, valued

at $632,027; Ohio, 10,748,986 pounds, valued at $317,027, and Pennsylvania, 8,367,707 pounds, valued at $305,244. Of the remaining states New York is credited with 4,193,905 pounds, $187,798; Minnesota with 2,176,152 pounds, $45,193; Illinois with 597,689 pounds, $23,729, and Indiana with 310,222 pounds, $10,691.

Table showing by states the number of persons employed in the fisheries of the Great Lakes in 1903.

State.	On vessels fishing.	On vessels transporting.	In shore fisheries.	Shoresmen.	Total.
New York	140	2	1,094	169	1,405
Pennsylvania	276	....	76	135	487
Ohio	213	12	649	227	1,101
Michigan	298	18	3,032	442	3,790
Indiana	6	....	30	2	38
Illinois	7	....	127	519	653
Wisconsin	264	6	1,191	175	1,636
Minnesota	7	....	185	31	223
Total	1,211	38	6,384	1,700	9,333

Table showing by states the apparatus and capital employed in the fisheries of the Great Lakes in 1903.

Item.	New York.		Pennsylvania.		Ohio.		Indiana.		Michigan.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	24	$77,100	44	$168,500	34	$112,050	1	$850	47	$155,050
Tonnage	436	....	698	....	619	....	10	....	1,002	....
Outfit	......	13,325	......	25,214	......	899	......	600	....	58,605
Vessels transporting	1	400	......	....	2	[illegible],000	......	....	8	23,600
Tonnage	14	....	......	....	126	....	......	....	69	....
Outfit	......	50	......	....	......	4,500	......	....	....	2,210
Boats	278	9,822	47	2,135	304	15,923	22	1,780	1,535	115,843
Gasoline launches	23	15,350	6	6,400	13	7,350	......	....	49	38,700
Apparatus—vessel fisheries:										
Pound nets	......	....	......	....	......	....	......	....	5	925
Gill nets	6,986	35,695	12,432	62,160	9,956	48,180	776	3,650	17,458	150,423
Turtle nets	......	....	......	....	70	210	......	....	....	....
Apparatus—shore fisheries:										
Pound nets and trap nets	199	13,845	116	20,305	988	131,715	9	2,645	2,703	297,647
Gill nets	4,514	37,912	1,464	6,828	1,594	3,668	264	1,244	15,881	98,307
Seines	8	205	......	....	90	6,595	......	....	66	3,746
Fyke nets	509	7,161	......	....	279	15,660	1	30	514	13,903
Lines	......	2,717	......	117	......	49	......	184	....	1,187
Fishing machines	6	600	......	....	......	....	......	....	....	....
Other apparatus	......	16	......	....	......	273	......	....	....	2,117
Shore property	......	171,150	......	140,300	......	628,430	......	2,500	....	735,038
Cash capital	......	186,250	......	64,000	......	185,500	......	....	....	340,279
Total	......	571,598	......	495,959	......	1,205,002	......	13,483	....	2,037,580

Table showing by states the apparatus and capital employed in the fisheries of the Great Lakes in 1903—Continued.

Item.	Illinois.		Wisconsin.		Minnesota.		Total.	
	No.	Value.	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	1	$3,500	42	$115,900	1	$1,500	194	$634,450
Tonnage	28		699		14		3,506	
Outfit		1,100		28,584		75		147,402
Vessels transporting			1	7,000			12	56,000
Tonnage			131				340	
Outfit				1,094				7,854
Boats	55	9,738	732	80,984	96	7,185	3,069	243,410
Gasoline launches			6	4,150	4	1,700	101	73,650
Apparatus—vessel fisheries:								
Pound nets							5	925
Gill nets	1,152	7,784	15,045	94,778	16	288	63,821	402,958
Lines				1,155				1,155
Turtle nets							70	210
Apparatus—shore fisheries:								
Pound nets and trap nets	5	1,450	499	117,066	4	400	4,523	585,073
Gill nets	791	4,160	12,184	69,834	1,376	18,050	38,068	240,003
Seines	3	86	27	1,830			194	12,462
Fyke nets	16	234	2,526	31,891			3,845	68,879
Lines		160		1,532		110		6,056
Fishing machines							6	600
Crawfish pots			4,560	1,100			4,560	1,100
Other apparatus		263		480				3,149
Shore property		959,800		189,991		42,398		2,869,607
Cash capital		1,219,750		99,000		24,700		2,119,479
Total		2,208,025		846,369		96,406		7,474,422

Table showing by states the products of the fisheries of the Great Lakes in 1903.

Species.	New York.		Pennsylvania.		Ohio.		Indiana.		Illinois.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	33,160	$2,200					20	$2		
Buffalo-fish							1,202	43		
Cat-fish and bullheads	351,795	13,011	12,315	$724	145,165	$5,780	360	25		
Eels	73,595	4,233					550	44		
Fresh-water drum	5,100	98	60,061	838	441,838	2,948	8,715	212	35	$1
German carp	37,880	849	29,650	451	3,058,207	50,695	8,820	398	20,700	778
Herring, fresh	1,610,639	63,402	5,750,352	207,763	1,530,867	67,777	76,465	2,302	93,195	2,761
Herring, salted	16,000	640								
Ling or lawyer, fresh	600	18			13,693	99	8,900	128	10,820	159
Pike and pickerel, fresh	31,359	2,080					115	10		
Pike perch (blue pike)	1,069,412	43,491	2,179,039	79,465	1,732,971	68,430				
Pike perch (wall-eyed)	29,391	1,560	13,633	953	636,985	34,303	40	4		
Pike perch (sauger)	7,000	490	7,427	321	1,857,628	44,948				
Rock bass	22,619	327			505	15				
Sturgeon	436,700	28,401	60,820	4,027	8,426	538	3,585	259	90	6
Caviar	17,217	10,829	840	670	275	247	44	30	12	9
Suckers, fresh	159,648	3,054	58,355	865	452,998	4,821	6,505	128	7,150	141
Sun-fish	35,289	490								
Trout, fresh	17,089	993			2,088	86	76,432	3,818	198,739	10,901
Trout, steelhead							9	1		
White bass	2,500	46	800	24	21,442	858				
White-fish, fresh	77,631	6,147	53,276	3,885	172,355	13,190	2,765	243	140	13
Yellow perch, fresh	158,781	5,189	141,139	5,258	624,743	19,925	115,695	3,044	266,808	8,960
Frogs	500	250								
Turtles					45,800	2,372				
Total	4,193,905	187,798	8,367,707	305,244	10,748,986	317,027	310,222	10,691	597,689	23,729

Table showing by states the products of the fisheries of the Great Lakes in 1903—Cont'd.

Species.	Michigan.		Wisconsin.		Minnesota.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	2,930	$279	2,627	$213			38,737	$2,694
Buffalo-fish	800	2					2,002	45
Cat-fish and bullheads	178,448	6,332	63,750	2,012			751,833	27,884
Dog-fish or bowfin	17,253	303					17,253	303
Eels	1,211	58	177	12			75,533	4,347
Fresh-water drum	230,272	1,603					746,021	5,700
German carp	580,496	10,492	501,890	7,622			4,237,643	71,285
Herring, fresh	2,182,454	45,574	6,378,522	92,972	1,096,829	$14,563	18,719,323	497,114
Herring, salted	7,747,746	173,692	5,422,843	138,580	248,127	5,150	13,434,716	318,062
Herring, smoked	3,290	252					3,290	252
Ling or lawyer, fresh	23,945	354	75,920	870			133,878	1,628
Ling or lawyer, salted	900	18					900	18
Minnows	3,000	800					3,000	800
Muskellunge	3,420	429					3,420	429
Pike and pickerel, fresh	201,573	9,495	65,419	4,083			298,466	15,668
Pike and pickerel, salted	1,610	30					1,610	30
Pike perch (blue pike)	68,300	1,938					4,981,422	191,386
Pike perch (wall-eyed)	2,249,869	125,049	146,229	6,415			3,076,147	168,284
Pike perch (sauger)							1,940,355	47,697
Rock bass	114,275	3,421					137,899	3,763
Sturgeon	87,428	5,467	21,526	1,096			618,575	39,794
Sturgeon caviar	1,875	1,402	60	86			20,323	13,223
Suckers, fresh	2,875,288	59,381	1,587,008	20,370			5,146,952	88,760
Suckers, salted	1,211,641	25,370	335,447	7,446			1,547,088	32,816
Sun-fish	48,982	1,391					84,271	1,881
Trout, fresh	9,102,747	399,968	5,574,681	259,257	280,446	8,750	15,252,222	668,773
Trout, salted	585,389	26,372	85,998	3,099	208,329	9,281	879,710	38,752
Trout, steelhead			160	16			169	17
White bass	2,009	63	300	9			30,051	995
White-fish, fresh	3,157,575	182,284	141,318	7,288	613	31	3,605,673	213,081
White-fish, salted	169,013	8,992	30,569	1,087	7,254	231	206,836	10,310
White-fish, smoked	350	35					350	35
White-fish, caviar	400	46					400	46
White-fish (bluefin), fresh	1,920,869	57,532	580,718	19,823	163,599	3,719	2,665,186	81,074
White-fish (bluefin), salted	33,423	1,309	7,806	247	20,553	819	61,782	2,375
White-fish (bluefin), smoked	3,000	300					3,000	300
White-fish (longjaw)	272,872	10,680	143,577	2,356	135,031	2,255	551,480	15,291
White-fish (Menominee), fresh	162,882	5,289	73,875	2,012	13,696	327	250,453	7,628
White-fish (Menominee), salted	104,380	4,586	68,800	3,119	1,675	67	174,855	7,772
Yellow perch, fresh	2,251,114	53,117	2,622,315	43,846			6,180,595	139,339
Yellow perch, salted	5,528	87	15,600	244			21,128	331
Crawfish			244,464	7,897			244,464	7,897
Frogs							500	250
Turtles							45,800	2,372
Total	35,608,557	1,223,792	24,191,599	632,027	2,176,152	45,193	86,194,817	2,745,501

Following are detailed statistics for the states in the foregoing table whose fisheries are conducted in more than one lake.

FISHERIES OF MICHIGAN.

This state touches lakes Erie, St. Clair and tributaries, Huron, Michigan, and Superior, but its fisheries are most extensive in Lake Huron and Lake Michigan.

Table showing by lakes the number of persons employed in the fisheries of Michigan in 1903.

How employed.	Lake Erie.	Lake St. Clair.[a]	Lake Huron.	Lake Michigan.	Lake Superior.	Total.
On fishing vessels			51	181	66	298
On transporting vessels			16	2		18
In shore fisheries	122	303	1,450	879	278	3,032
Shoresmen		52	187	131	72	442
Total	122	355	1,704	1,193	416	3,790

[a] Includes St. Clair and Detroit rivers.

Table showing by lakes the apparatus and capital employed in the fisheries of Michigan in 1903.

Items.	Like Erie.		Lake St. Clair.[a]		Lake Huron.	
	No.	Value.	No.	Value.	No.	Value.
Vessel fishing					8	$24,000
Tonnage					129	
Outfit						10,795
Vessels transporting					7	21,700
Tonnage					59	
Outfit						2,200
Boats	64	$1,825	150	$3,150	[b]606	45,173
Gasoline launches	2	830			22	22,550
Apparatus—vessel fisheries:						
Gill nets					[b]2,222	25,625
Apparatus—shore fisheries:						
Pound nets and trap nets	342	16,885			1,685	176,495
Gill nets					3,907	25,901
Seines	20	1,445	6	890	18	608
Fyke nets	28	830			443	12,583
Lines		20		325		183
Other apparatus				636		1,211
Shore property		2,975		141,805		387,115
Cash capital				93,079		95,500
Total		24,830		239,885		851,639

Items.	Lake Michigan.		Lake Superior.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	30	$94,450	9	$36,600	47	$155,050
Tonnage	580		293		1,002	
Outfit		34,445		13,365		58,605
Vessels transporting	1	1,900			8	23,600
Tonnage	10				69	
Outfit		10				2,210
Boats	569	56,710	146	8,985	1,535	115,843
Gasoline launches			25	15,300	49	38,700
Apparatus—vessel fisheries:						
Pound nets	5	925			5	925
Gill nets	12,182	78,894	3,054	45,904	17,458	150,423
Apparatus—shore fisheries:						
Pound nets and trap nets	518	86,600	158	17,667	2,703	297,647
Gill nets	8,874	39,248	3,100	33,158	15,881	98,307
Seines	22	803			66	3,746
Fyke nets	18	240	25	250	514	13,908
Lines		593		66		1,187
Other apparatus		2		268		2,117
Shore property		131,575		71,568		735,038
Cash capital		67,200		84,500		340,279
Total		593,595		327,631		2,037,580

[a] Includes St. Clair and Detroit rivers.
[b] Includes 5 steam tugs under 5 net tons, valued at $4,600.

Table showing by lakes and species the yield of the fisheries of Michigan in 1903.

Species.	Lake Erie.		Lake St. Clair.[a]		Lake Huron.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Buffalo-fish			800	$2		
Cat-fish and bullheads	21,724	$859			155,826	$5,444
Dog-fish	1,062	6			16,191	297
Eels					1,211	58
Fresh-water drum	139,746	715	10,200	126	47,426	309
German carp	437,335	7,635	102,000	1,812	37,491	954
Herring, fresh	2,082	72			1,144,094	14,561
Herring, salted					3,496,233	68,141
Herring, smoked					640	40
Ling or lawyer					80	2
Minnows			3,000	800		
Muskellunge			3,000	405	420	24
Pike and pickerel, fresh			20,200	1,185	145,407	6,980
Pike and pickerel, salted					1,610	30
Pike perch (sauger)	68,300	1,938				
Pike perch (wall-eyed)	236,500	13,296	250,650	12,964	1,598,674	89,992
Rock bass			3,700	185	110,575	3,236
Sturgeon	1,870	124	8,725	569	34,047	2,162
Sturgeon caviar	50	45	75	60	296	241
Suckers, fresh	149,148	1,764	82,900	1,027	2,061,578	48,974
Suckers, salted					628,576	12,886
Sun-fish			6,500	325	42,432	1,066
Trout, fresh					2,086,880	99,386
Trout, salted					21,752	738
White bass	1,909	57				
White-fish, fresh	24,927	1,888	25,591	1,904	654,862	40,679
White-fish, salted					38,101	1,327
White-fish caviar					400	46
White-fish (longjaw)					74,400	2,672
White-fish (Menominee), fresh					116,700	3,926
White-fish (Menominee), salted					28,755	1,321
Yellow perch, fresh	37,905	900	4,600	230	1,911,002	44,826
Total	1,122,558	29,299	521,941	21,594	14,455,209	450,318

Species.	Lake Michigan.		Lake Superior.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	2,930	$279			2,930	$279
Buffalo-fish					800	2
Cat-fish and bullheads	310	11	588	$18	178,448	6,332
Dog-fish					17,253	303
Eels					1,211	58
Fresh-water drum	32,900	453			230,272	1,603
German carp	3,670	91			580,496	10,492
Herring, fresh	827,667	27,012	208,611	3,929	2,182,454	45,574
Herring, salted	4,108,300	102,379	143,213	3,172	7,747,746	173,692
Herring, smoked	2,650	212			3,290	252
Ling or lawyer	23,865	352			23,945	354
Ling or lawyer, salted	900	18			900	18
Minnows					3,000	800
Muskellunge					3,420	429
Pike and pickerel, fresh	25,174	1,115	10,792	215	201,573	9,495
Pike and pickerel, salted					1,610	30
Pike perch (sauger)					68,300	1,938
Pike perch (wall-eyed)	134,918	7,874	29,127	923	2,249,869	125,049
Rock bass					114,275	3,421
Sturgeon	40,180	2,452	2,606	160	87,428	5,467
Sturgeon caviar	1,454	1,056			1,875	1,402
Suckers, fresh	558,512	7,153	23,150	463	2,875,288	59,381
Suckers, salted	581,665	12,444	1,400	40	1,211,641	25,370
Sun-fish					48,982	1,391
Trout, fresh	4,084,836	189,653	2,931,031	110,929	9,102,747	399,968
Trout, salted	76,476	3,280	487,161	22,354	585,389	26,372
White bass	100	6			2,009	63
White-fish, fresh	1,804,148	108,083	648,547	29,730	3,157,575	182,284
White-fish, salted	122,212	7,246	8,700	419	169,013	8,992
White-fish, smoked	350	35			350	35
White-fish caviar					400	46
White-fish (bluefin), fresh	231,200	9,580	1,689,669	47,952	1,920,869	57,532
White-fish (bluefin), salted			33,423	1,309	33,423	1,309
White-fish (bluefin), smoked	3,000	300			3,000	300
White-fish (longjaw)	186,505	7,809	11,967	199	272,872	10,680
White-fish (Menominee), fresh	45,959	1,356	223	7	162,882	5,289
White-fish (Menominee), salted	75,625	3,265			104,380	4,586
Yellow perch, fresh	287,442	7,060	10,165	101	2,251,114	53,117
Yellow perch, salted	5,528	87			5,528	87
Total	13,268,476	500,661	6,240,373	221,920	35,608,557	1,223,792

[a] Includes St. Clair and Detroit rivers.

FISHERIES OF WISCONSIN.

Wisconsin borders on Lakes Michigan and Superior. The extent of the fisheries of the state in each of these lakes is shown in the following tables:

Table showing by lakes the number of persons employed in the fisheries of Wisconsin in 1903.

How employed.	Lake Michigan.	Lake Superior.	Total.
On fishing vessels	168	96	264
On transporting vessels		6	6
In shore fisheries	1,041	150	1,191
Shoresmen	148	27	175
Total	1,357	279	1,636

Table showing by lakes the apparatus and capital employed in the fisheries of Wisconsin in 1903.

Item.	Lake Michigan.		Lake Superior.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	32	$85,300	10	$30,600	42	$115,900
Tonnage	498		201		699	
Outfit		19,387		9,197		28,584
Vessels transporting			1	7,000	1	7,000
Tonnage			131		131	
Outfit				1,094		1,094
Boats	652	76,626	80	4,358	732	80,984
Launches			6	4,150	6	4,150
Apparatus—vessel fisheries:						
Gill nets	13,660	77,432	1,385	17,346	15,045	94,778
Lines		1,155				1,155
Apparatus—shore fisheries:						
Pound nets and trap nets	443	107,340	56	9,726	499	117,066
Gill nets	10,946	57,342	1,238	12,492	12,184	69,834
Fyke nets	2,526	31,891			2,526	31,891
Seines	19	1,495	8	335	27	1,830
Lines		1,411		121		1,532
Crawfish pots	4,560	1,100			4,560	1,100
Other apparatus		480				480
Shore property		147,625		42,366		189,991
Cash capital		65,500		33,500		99,000
Total		674,084		172,285		846,369

Table showing by lakes and species the yield of the fisheries of Wisconsin in 1903.

Species.	Lake Michigan.		Lake Superior.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black bass	2,627	$213			2,627	$213
Cat-fish and bullheads	63,750	2,012			63,750	2,012
Eels	177	12			177	12
German carp	501,890	7,622			501,890	7,622
Herring, fresh	3,376,540	74,898	3,001,982	$18,074	6,378,522	92,972
Herring, salted	5,378,800	137,784	44,043	796	5,422,843	138,580
Ling or lawyer	75,920	870			75,920	870
Pike and pickerel	65,345	4,080	74	3	65,419	4,083
Pike perch (wall-eyed)	81,525	3,887	64,704	2,528	146,229	6,415
Sturgeon	10,995	691	10,531	405	21,526	1,096
Caviar	60	36			60	36
Suckers, fresh	1,561,609	20,109	25,399	261	1,587,008	20,370
Suckers, salted	202,100	5,287	133,347	2,159	335,447	7,446
Trout, fresh	4,595,416	221,840	979,265	37,417	5,574,681	259,257
Trout, salted	17,400	939	68,598	2,160	85,998	3,099
Trout, steelhead	160	16			160	16
White bass	300	9			300	9
White-fish, fresh	42,979	3,064	98,339	4,224	141,318	7,288
White-fish, salted			30,569	1,087	30,569	1,087
White-fish (bluefin), fresh	400,464	14,982	180,254	4,841	580,718	19,823
White-fish (bluefin), salted			7,806	247	7,806	247
White-fish (longjaw)			143,577	2,356	143,577	2,356
White-fish (Menominee), fresh	73,875	2,012			73,875	2,012
White-fish (Menominee), salted	68,800	3,119			68,800	3,119
Yellow perch, fresh	2,622,315	43,846			2,622,315	43,846
Yellow perch, salted	15,600	244			15,600	244
Crawfish	244,464	7,897			244,464	7,897
Total	19,403,111	555,469	4,788,488	76,558	24,191,599	632,027

FISHERIES OF NEW YORK.

The fisheries of New York in the Great Lakes are conducted in Lake Ontario and the St. Lawrence and Niagara rivers, and also in two counties, Erie and Chautauqua, on Lake Erie. Their extent in 1903 is shown in the following tables:

Table showing by lakes the number of persons employed in the fisheries of New York in 1903.

How employed.	Lake Ontario.[a]	Lake Erie.	Total.
On vessels fishing	8	132	140
On vessels transporting	2		2
In shore fisheries	340	744	1,094
Shoresmen	28	141	169
Total	378	1,017	1,405

[a] Includes St. Lawrence and Niagara rivers.

Table showing by lakes the apparatus and capital employed in the fisheries of New York in 1903.

Item.	Lake Ontario.[a]		Lake Erie.		Total.	
	No.	Value.	No.	Value.	No.	Value.
Vessels fishing	2	$4,000	22	$73,100	24	$77,100
Tonnage	20		416		436	
Outfit		510		12,815		13,325
Vessels transporting	1	400			1	400
Tonnage	14				14	
Outfit		50				50
Boats	226	7,497	52	2,325	278	9,822
Gasoline boats	5	3,000	18	12,350	23	15,350
Apparatus—vessel fisheries:						
Gill nets	620	2,920	6,366	32,775	6,986	35,695
Apparatus—shore fisheries:						
Pound nets and trap nets	176	9,945	23	3,900	199	13,845
Gill nets	1,176	10,942	3,338	26,970	4,514	37,912
Fyke nets	509	7,161			509	7,161
Seines	8	205			8	205
Lines		1,526		1,191		2,717
Spears		16				16
Fishing machines	6	600			6	600
Shore property		23,220		147,930		171,150
Cash capital		29,000		157,250		186,250
Total		100,992		470,606		571,598

a Includes St. Lawrence and Niagara rivers.

Table showing by lakes and species the yield of the fisheries of New York, in 1903.

Species.	Lake Ontario.[a]		Lake Erie.		Total.	
	Lbs.	Value.	Lbs.	Value.	Lbs.	Value.
Black Bass	28,335	$1,813	4,825	$387	33,160	$2,200
Cat-fish and bullheads	349,224	12,903	2,571	108	351,795	13,011
Eels	73,595	4,233			73,595	4,233
Fresh-water drum	4,300	86	800	12	5,100	98
German carp	16,320	432	21,560	417	37,880	849
Herring, fresh	105,315	5,170	1,505,324	58,232	1,610,639	63,402
Herring, salted	16,000	640			16,000	640
Ling or lawyers	600	18			600	18
Pike and pickerel	31,359	2,080			31,359	2,080
Pike perch (blue pike)	66,065	3,353	1,003,347	40,138	1,069,412	43,491
Pike perch (wall-eyed)	8,025	650	21,366	910	29,391	1,560
Pike perch (sauger)			7,000	490	7,000	490
Rock bass	22,119	321	500	6	22,619	327
Sturgeon	213,590	11,504	223,110	16,897	436,700	28,401
Caviar	12,505	6,897	4,712	3,932	17,217	10,829
Suckers	99,060	1,809	60,588	1,245	159,648	3,054
Sun-fish	34,089	482	1,200	8	35,289	490
Trout	4,050	279	13,039	714	17,089	993
White bass	2,000	40	500	6	2,500	46
White-fish	25,384	2,122	52,247	4,025	77,631	6,147
Yellow perch	132,165	4,271	26,616	918	158,781	5,189
Frogs	500	250			500	250
Total	1,244,600	59,353	2,949,305	128,445	4,193,905	187,798

a Includes St. Lawrence and Niagara rivers.

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